PEMBELAJARAN EKOSISTEM MELALUI SISTEM PERMAKULTUR BERBANTUAN *ECO-GAMIFICATION* SEBAGAI UPAYA UNTUK MENINGKATKAN KOMPETENSI BERPIKIR SISTEM DAN KOLABORASI PESERTA DIDIK

TESIS

diajukan untuk memenuhi salah satu syarat memperoleh gelar magister pada
Program Studi Pendidikan Biologi

Oleh:

Rahmat Baharuddin
NIM 2310624

PROGRAM STUDI MAGISTER PENDIDIKAN BIOLOGI
FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA
2025

LEMBAR HAK CIPTA

PEMBELAJARAN EKOSISTEM MELALUI SISTEM PERMAKULTUR BERBANTUAN *ECO-GAMIFICATION* SEBAGAI UPAYA UNTUK MENINGKATKAN KOMPETENSI BERPIKIR SISTEM DAN KOLABORASI PESERTA DIDIK

oleh
Rahmat Baharuddin

Sebuah tesis yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Magister Pendidikan pada Program Studi Pendidikan Biologi Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

Universitas Pendidikan Indonesia
Agustus 2025

HALAMAN PENGESAHAN

RAHMAT BAHARUDDIN
2310624

PEMBELAJARAN EKOSISTEM MELALUI SISTEM PERMAKULTUR BERBANTUAN *ECO-GAMIFICATION* SEBAGAI UPAYA UNTUK MENINGKATKAN KOMPETENSI BERPIKIR SISTEM DAN KOLABORASI PESERTA DIDIK

Disetujui dan disahkan oleh pembimbing:

Pembimbing I

Dr. Saefudin, M.Si.
NIP. 19630701198831003

Pembimbing II

Dr. Kusnadi, M.Si.
NIP. 196805091994031001

Mengetahui,
Ketua Program Studi Magister Pendidikan Biologi

Dr. Kusnadi, M.Si.
NIP. 196805091994031001

PERNYATAAN BEBAS PLAGIARISME

Saya yang bertanda tangan di bawah ini:

Nama : Rahmat Baharuddin

NIM : 2310624

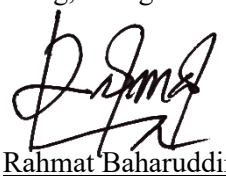
Program Studi : Magister Pendidikan Biologi

Judul Karya : Pembelajaran Ekosistem melalui Sistem Permakultur Berbantuan *Eco-Gamification* sebagai Upaya untuk Meningkatkan Kompetensi Berpikir Sistem dan Kolaborasi Peserta Didik.

Dengan ini menyatakan bahwa karya tulis ini merupakan hasil kerja saya sendiri. Saya menjamin bahwa seluruh isi karya ini, baik sebagian maupun keseluruhan, bukan merupakan plagiarisme dari karya orang lain, kecuali pada bagian yang telah dinyatakan dan disebutkan sumbernya dengan jelas.

Jika di kemudian hari ditemukan pelanggaran terhadap etika akademik atau unsur plagiarisme, saya bersedia menerima sanksi sesuai peraturan yang berlaku di Universitas Pendidikan Indonesia.

Bandung, 17 Agustus 2025



Rahmat Baharuddin

KATA PENGANTAR

Segala puji bagi Allah Yang Maha Suci dan Maha Tinggi. Doa kebaikan dan salam bagi Nabi Muhammad, keluarga, sahabat, dan seluruh umatnya yang senantiasa berpegang teguh pada ajaran Islam. Atas pertolongan dan karunia dari Allah, penulis dapat menyelesaikan tesis berjudul "Pembelajaran Ekosistem melalui Sistem Permakultur Berbantuan *Eco-Gamification* sebagai Upaya untuk Meningkatkan Kompetensi Berpikir Sistem dan Kolaborasi Peserta Didik". Tesis tersebut diajukan sebagai salah satu syarat untuk memperoleh gelar Magister Pendidikan pada Program Studi Magister Pendidikan Biologi Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam Universitas Pendidikan Indonesia.

Penulis menyadari adanya berbagai keterbatasan menyebabkan penulisan tesis ini tidak terlepas dari kekurangan. Maka dari itu, kritik dan saran dari pembaca sangat berarti bagi pengembangan ilmu pengetahuan dan peningkatan kualitas penulisan di masa mendatang. Semoga penelitian dan penulisan tesis ini memberikan manfaat bagi pembaca dan memperkaya bidang keilmuan pendidikan sains khususnya biologi. Penyelesaian tesis ini tidak terlepas dari peran besar dan dukungan dari berbagai pihak, oleh karena itu penulis ingin menyampaikan ucapan terima kasih atas bantuan yang telah diberikan.

Penghargaan setulus hati dan ucapan terima kasih penulis tujukan kepada Bapak Dr. Saefudin, M.Si selaku dosen penasehat akademik sekaligus pembimbing I serta Bapak Dr. Kusnadi, M.Si selaku pembimbing II yang senantiasa membimbing dan memberi buah pikiran sehingga penulis dapat merampungkan tesis ini. Ucapan terima kasih juga penulis tujukan kepada Ibu Dr. Rini Solihat, M.Si dan Bapak Dr. Amprasto, M.Si selaku dosen penguji yang telah memberikan kritik dan saran untuk perbaikan tesis ini. Selain itu, penulis juga mengucapkan terima kasih kepada seluruh pihak yang tidak dapat penulis tuliskan satu persatu atas bantuannya dalam penyelesaian tesis ini. Semoga Allah membalas kebaikan seluruh pihak yang telah membantu penyelesaian tesis ini.

Bandung, 2025

Penulis

ABSTRAK

Penelitian ini bertujuan untuk mengkaji peningkatan kompetensi berpikir sistem dan kolaborasi peserta didik setelah mengikuti pembelajaran ekosistem melalui sistem permakultur berbantuan *eco-gamification*. Permakultur merupakan ekosistem buatan yang mendukung praktik agrikultur berkelanjutan. Terdapat empat pos pembelajaran pada sistem permakultur meliputi pos perkebunan, akuaponik, pengomposan, dan budidaya lalat tentara hitam (*Hermetia illucens*). Elemen gamifikasi seperti papan skor, pemberian hadiah, dan kompetisi kelompok maupun individu diintegrasikan pada pembelajaran melalui *eco-gamification*. Penelitian ini menggunakan metode kuasi eksperimen dengan *nonequivalent control-group pretest and posttest design*. Sampel pada penelitian ini merupakan 50 peserta didik kelas X pada salah satu Sekolah Menengah Atas di Kota Bandung. Kelas eksperimen mengikuti pembelajaran ekosistem melalui sistem permakultur berbantuan *eco-gamification*, sedangkan kelas kontrol mengikuti pembelajaran yang biasanya guru lakukan di kelas. Instrumen tes berupa soal uraian digunakan untuk mengukur kompetensi berpikir sistem peserta didik. Sementara itu, kompetensi kolaborasi peserta didik diukur menggunakan *self-assessment, peer assessment,* dan lembar observasi. Hasil analisis data menunjukkan bahwa peningkatan kompetensi berpikir sistem peserta didik di kelas eksperimen lebih tinggi dibandingkan kelas kontrol, perbedaan tersebut signifikan berdasarkan hasil uji t ($p = 0,02$). Sementara itu, meskipun peningkatan kompetensi kolaborasi di kelas eksperimen juga lebih tinggi, perbedaan tersebut tidak signifikan ($p = 0,64$). Temuan ini menunjukkan bahwa pembelajaran ekosistem melalui sistem permakultur berbantuan *eco-gamification* secara signifikan meningkatkan kompetensi berpikir sistem dan berdampak positif terhadap pengembangan kompetensi kolaborasi peserta didik.

Kata kunci: berpikir sistem, ekosistem, kolaborasi, pembelajaran permakultur berbantuan *eco-gamification.*

ABSTRACT

This study aims to investigate the improvement of students' systems thinking and collaboration competencies through permaculture learning integrated with eco-gamification in ecosystem topics. Permaculture is an artificial ecosystem that promotes sustainable agriculture. There are four learning stations within the permaculture including mini garden, aquaponic installation, composting site, and black soldier fly farm. Gamification elements such as rewards, score achievements, and both group and individual competition are applied through eco-gamification, which is implemented in an outdoor environment within the permaculture setting. A quasi-experimental nonequivalent control-group design with pretest and posttest was employed, involving 50 tenth-grade students from a high school in Bandung. The experimental group participated in permaculture learning with eco-gamification, while the control group received the regular learning process. Systems thinking competency was assessed using essay-based tests, while collaboration competency was measured through self-assessment, peer assessment, and observation rubrics. The t-test results showed a significant difference in the improvement of students' systems thinking competency between the two groups (p = 0.01). Meanwhile, there was no significant difference in the improvement of students' collaboration competency (p = 0,26). However, students in the experimental group demonstrated greater improvement compared to those in the control group. It suggests that permaculture learning integrated with eco-gamification in ecosystem topics may still support the development of collaboration competency. Overall, the findings suggest that permaculture learning integrated with eco-gamification in ecosystem topics is particularly effective in improving systems thinking competency, with potential benefits for collaboration as well.

Keywords: *collaboration, ecosystem, permaculture with eco-gamification learning, systems thinking.*

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., Alshihri, F. S., & Alrawaf, T. I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. *International Journal of Environmental and Public Health*, *19*(12717), 1–26. https://doi.org/10.3390/ijerph191912717

Adhiatma, A., Rahayu, T., & Fachrunnisa, O. (2019). Gamified Training: A New Concept to Improve Individual Soft Skills. *Jurnal Siasat Bisnis*, *23*(2), 127–141. https://doi.org/10.20885/jsb.vol23.iss2.art5

Aggrawal, S., & Magana, A. J. (2024). Teamwork Conflict Management Training and Conflict Resolution Practice via Large Language Models. *Future Internet*, *16*(5), 1–25. https://doi.org/10.3390/fi16050177

Agustina, I., Joshua, W., Julanos, J., & Niva, M. (2024). The Impact of Implementing Game-Based Learning on Student Motivation and Engagement. *Journal Emerging Technologies in Education*, *2*(3), 241–253. https://doi.org/10.70177/jete.v2i3.1069

Aini, M., Narulita, E., & Indrawati. (2020). Enhancing Creative Thinking and Collaboration Skills Through ILC3 Learning Model: A Case Study. *Journal of Southwest Jiaotong University*, *55*(4), 1–13. https://doi.org/10.35741/issn.0258-2724.55.4.59

Aisy, M. R., & Gunansyah, G. (2020). Praktik Education Sustainable Development : Studi Komparasi Di Sekolah Dasar Kota Surabaya. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *8*(2), 1–11.

Aisyah, S. N., & Rizki, M. I. (2023). Community Empowerment of PCM Kokap on Sustainable Municipal Waste Management through Black Soldier Fly Farming. *International Journal of Community Service Learning*, *7*(4), 477–485. https://doi.org/10.23887/ijcsl.v7i4.67536

Akhtar, F., Lodhi, S. A., Khan, S. S., & Sarwar, F. (2016). Incorporating Permaculture and Strategic Management for Sustainable Ecological Resource Management. *Journal of Environmental Management*, *179*, 31–37. https://doi.org/10.1016/j.jenvman.2016.04.051

Akiri, E., Tal, M., Peretz, R., Dori, D., & Dori, Y. J. (2020). STEM Graduate Students' Systems Thinking, Modeling and Scientific Understanding The Case of Food Production. *Applied Sciences (Switzerland)*, *10*(21), 1–23. https://doi.org/10.3390/app10217417

Al-Mubireek, S. (2021). The Effects of Cooperative Learning versus Traditional Teaching on Students' Achievement: A Case Study. *TESOL International*

Journal, *16*(2), 31–55. https://eric.ed.gov/?id=EJ1329402

Alakendu, P. R., Afiya, R, S., Senthilkumar, S., & Manivannan, S. (2024). Permaculture : A Sustainable Farming Approach for Modern Era. *Haya: The Saudi Journal of Life Sciences*, *9*(7), 305–312. https://doi.org/10.36348/sjls.2024.v09i07.009

Alcock, I., White, M. P., Pahl, S., Duarte-Davidson, R., & Fleming, L. E. (2020). Associations between Pro-Environmental Behaviour and Neighbourhood Nature, Nature Visit Frequency and Nature Appreciation: Evidence from a Nationally Representative Survey in England. *Environment International*, *136*, 105441. https://doi.org/10.1016/j.envint.2019.105441

Alderslowe, L., Amus, G., & Didi, A. D. (2018). *Earth Care, People Care and Fair Share in Education: The Children in Permaculture Manual*. Eco-Logic Books.

Alford, K. R., Stedman, N. L. P., Bunch, J., Baker, S., & Roberts, T. G. (2024). Real-World Experiences in Higher Education: Contributing to the Developing a Systems Thinking Paradigm. *Journal of Experiential Education*. https://doi.org/10.1177/10538259241259626

Almazovaite, M., Cohn, E. P., & Kumar, S. (2024). Group Projects as Spaces for Leadership Development in the Liberal Arts Classroom: A Case of American Undergraduate Students. *Frontiers in Education*, *9*(1480929), 1–11. https://doi.org/10.3389/feduc.2024.1480929

Amrul, N. F., Ahmad, I. K., Basri, N. E. A., Suja, F., Jalil, N. A. A., & Azman, N. A. (2022). A Review of Organic Waste Treatment Using Black Soldier Fly (Hermetia illucens). *Sustainability (Switzerland)*, *14*(8), 1–15. https://doi.org/10.3390/su14084565

Anantasuk, N. (2019). Effects of Problem-Based Learning Approach on Problem-Solving Skills and Cooperative Working Ability of Eighth-Grade Students. *PEOPLE: International Journal of Social Sciences*, *4*(3), 1277–1284. https://doi.org/10.20319/pijss.2019.43.12771284

Andriyatno, I., Purwianingsih, W., & Rini, S. (2024). Improving Students' Collaboration Skills Through Project -Based Learning on Environmental Change Material. *International Conference on Special Education and Diversity (IConSED)*, *34*, 71–79. https://doi.org/10.55549/epess.793

Ansar, M., Alwi, M. A., Nurfiriany, F., & Muh, D. (2023). The Influence of Task Difficulty Level on Academic Social Loafing. *Proceedings of the Unima International Conference on Social Sciences and Humanities (UNICSSH 2022)*, *January*, 99–105. https://doi.org/10.2991/978-2-494069-35-0_141

Aprilia, D., Dianti, Kirana, N. A., Agustina, P. C., Lia, K., Sarno, Khairul, A. B. A.

R., & Ahmad, D. S. (2022). Review: Biogeochemical Process in Mangrove Ecosystem. *International Journal of Bonorowo Wetlands*, *10*(2), 126–141. https://doi.org/10.13057/bonorowo/w100205

Aragón, L., & Manzano, B. E. (2025). Can School Gardens Contribute to Resilient Communities from a Scientific and Eco-Social Perspective in Early Childhood Education? *Journal of Outdoor and Environmental Education*, *1*(1), 1–23. https://doi.org/10.1007/s42322-024-00185-1

Arduini, G. (2022). Permaculture Principles as a Teaching Design System. *Formazione & Insegnamento*, *20*(1), 312–317. https://doi.org/10.7346/-fei-XX-01-22_29

Arifin, S., Setyosari, P., Sa'dijah, C., & Kuswandi, D. (2020). The Effect of Problem Based Learning by Cognitive Style on Critical Thinking Skills and Student Retention. *Journal of Technology and Science Education*, *10*(2), 271–281. http://www.jotse.org/index.php/jotse/article/view/790/477

Arnold, R. D., & Wade, J. P. (2015). A Definition of Systems Thinking: A Systems Approach. *Conference on Systems Engineering Research*, *44*, 669–678. https://doi.org/10.1016/j.procs.2015.03.050

Arnone, S., De Mei, M., Petrazzuolo, F., Musmeci, S., Tonelli, L., Salvicchi, A., Defilippo, F., Curatolo, M., & Bonilauri, P. (2022). Black Soldier Fly (Hermetia Illucens L.) as a High-Potential Agent for Bioconversion of Municipal Primary Sewage Sludge. *Environmental Science and Pollution Research*, *29*(43), 64886–64901. https://doi.org/10.1007/s11356-022-20250-w

Arora, N. K., & Mishra, I. (2023). Responsible Consumption and Production: A Roadmap to Sustainable Development. *Environmental Sustainability*, *6*(1), 1–6. https://doi.org/10.1007/s42398-023-00266-9

Arrahman, T., Suriansyah, A., Arta, M. B. H., Diani, A. P., & Akhmad, R. A. (2024). Game Based Learning (GBL) Terintegrasi Teknologi Dalam Peningkatan Minat Baca Siswa di SDN Kampung Baru. *Joyful Learning Journal*, *13*(4), 83–90. https://journal.unnes.ac.id/journals/jlj/article/view/18012/2609

Arsyad, M., Layli R, N., & Abdullah, G. (2024). The Role of Nature Education in Building Students' Emotional Connections with the Environment. *Scientica Education Journal*, *1*(5), 1–9. https://doi.org/10.62872/w3q1sb23

Artina, B. S., Desnasari, D., Fitriyah, F., & Rizkita, R. G. (2020). The Workforce in Indonesian Organizations: An Analysis Based Upon the Cultural Dimensions of Hofstede's Model. *Journal of International Conference Proceedings*, *3*(1), 56–64. https://doi.org/10.32535/jicp.v2i4.780

Asghar, A., Akram, T. M., & Hafeez, R. (2024). Perception of Secondary and Higher Secondary School Students about the Role of Permaculture to sustain the Living System. *Pakistan Social Sciences Review*, *8*(2), 288–297. https://doi.org/10.35484/pssr.2024(8-II)25

Asmayawati, Yufiarti, & Yetti, E. (2024). Pedagogical Innovation and Curricular Adaptation in Enhancing Digital Literacy: A Local Wisdom Approach for Sustainable Development in Indonesia Context. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(1), 1–15. https://doi.org/10.1016/j.joitmc.2024.100233

Assapun, S., & Thummaphan, P. (2023). Assessing the Effectiveness of Board Game-based Learning for Enhancing Problem-Solving Competency of Lower Secondary Students. *International Journal of Instruction*, *16*(2), 511–532. https://doi.org/10.29333/iji.2023.16228a

Assaraf, O. B., & Orion, N. (2005). Development of System Thinking Skills in the Context of Earth System Education. *Journal of Research in Science Teaching*, *42*(5), 518–560. https://doi.org/10.1002/tea.20061

Astuti, Y. D., Milinda, M., Safira, P. D., & Titiyaka, J. (2024). Identification of High School Students' Misconceptions on The Biogeochemical Cycle Topics. *Jurnal Pendidikan Sains Indonesia*, *12*(1), 172–181. https://doi.org/10.2481 5/jpsi.v1 2i1.34974

Attenborough, M. (2003). *Mathematics for Electrical Engineering and Computing*. Newnes. https://doi.org/10.1016/B978-0-7506-5855-3.X5025-6

Ayotte-Beaudet, J. P., Chastenay, P., Beaudry, M. C., L'Heureux, K., Giamellaro, M., Smith, J., Desjarlais, E., & Paquette, A. (2023). Exploring the Impacts of Contextualised Outdoor Science Education on Learning: The Case of Primary School Students Learning about Ecosystem Relationships. *Journal of Biological Education*, *57*(2), 277–294. https://doi.org/10.1080/00219266.2021.1909634

Azevedo, H., Soares-Silva, I., Fonseca, F., Alves, P., Silva, D., & Azevedo, M. M. (2022). Impact of Educational Gardens and Workshop Activities on 8th-Grade Student's Perception and Knowledge of Plant Biology. *Education Sciences*, *12*(9), 1–16. https://doi.org/10.3390/educsci12090619

Azhar, S. A. F. J., & Jalil, H. A. (2022). Comparison of Individual and Collaborative Game-Based Learning Using Tablet In Improving Students' Knowledge In Primary Classroom Environment. *Asian Journal of University Education*, *18*(1), 205–216. https://doi.org/10.24191/ajue.v18i1.17188

Azwar, S. (2012). *Penyusunan Skala Psikologi* (2nd ed.). Pustaka Pelajar.

Badan Perencanaan Pembangunan Nasional. (2022). *Pedoman Teknis Penyusunan Rencana Aksi: Tujuan Pembangunan Berkelanjutan (TPB)/Sustainable Development Goals (SDGs)*. Kementerian Perencanaan Pembangunan Nasional. https://sdgs.bappenas.go.id/website/wp-content/uploads/2023/11/Lampiran-I-RAN-SDGs-2021-2024.pdf

Badan Pusat Statistik. (2024). *Statistik Indonesia: Statistical Yearbook of Indonesia*. Badan Pusat Statistik.

Badan Standar, Kurikulum, dan A. P. (2022). *Dimensi, Elemen, dan Subelemen Profil Pelajar Pancasila pada Kurikulum Merdeka*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. https://kurikulum.kemdikbud.go.id/wp-content/uploads/2022/07/V.2-Dimensi-elemen-subelemen-Profil-Pelajar-Pancasila-pada-Kurikulum-Merdeka.pdf

Badan Standar, Kurikulum, dan A. P. (2024). *Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah pada Kurikulum Merdeka* (Issue 032/H/KR/2024). Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. https://kurikulum.kemdikbud.go.id/file/1718471412_manage_file.pdf

Baharuddin, R., & Kurnia, N. (2020). Analisis Kebutuhan Pengembangan LKPD dan Handout Berbasis Pendekatan Saintifik Materi Pembelahan Sel. *Inovasi Penelitian Biologi Dan Pembelajarannya Di Era Merdeka*, 1–5. https://ojs.unm.ac.id/semnasbio/article/view/20083/0

Bai, S., Hew, K. F., & Huang, B. (2020). Does Gamification Improve Student Learning Outcome? Evidence from a Meta-Analysis and Synthesis of Qualitative Data in Educational Contexts. *Educational Research Review*, *30*, 1–20. https://doi.org/10.1016/j.edurev.2020.100322

Barajas, E. R., Vela, C. A., & Huerta, J. H. K. Z. (2016). Exploring University Teacher Perceptions About Out-of-Class Teamwork. *PROFILE Issues in Teachers' Professional Development*, *18*(2), 1–17. https://doi.org/10.15446/profile.v18n2.53364

Barbosa, M. P., & Maciel, R. S. P. (2025). Interpersonal Trust Among Students in Virtual Learning Environments: A Comprehensive Review. *Cornell University*, 1–63. http://arxiv.org/abs/2503.17976

Barragán-Fonseca, K. B., Cortés-Urquijo, J., Pineda-Mejía, J., Lagos-Sierra, D., & Dicke, M. (2023). Small-Scale Black Soldier Fly-Fish Farming: A Model with Socioeconomic Benefits. *Animal Frontiers*, *13*(4), 91–101. https://doi.org/10.1093/af/vfad030

Beery, M., Adatia, R., Segantin, O., & Skaer, C. F. (2014). School Food Gardens: Fertile Ground for Education. *Health Education*, *114*(4), 281–292.

https://doi.org/10.1108/HE-05-2013-0019

Beghetto, R. A. (2017). Inviting Uncertainty into The Classroom: Five Strategies to Help Students Respond Well to Uncertainty and Foster Complex Problem-Solving Skills. *Educational Leadership*, *75*(2), 20–25. http://www.scopus.com/inward/record.url?scp=85034817067&partnerID=8YFLogxK

Behl, D. V., & Ferreira, S. (2014). Systems Thinking: An Analysis of Key Factors and Relationships. *Procedia Computer Science*, *36*, 104–109. https://doi.org/10.1016/j.procs.2014.09.045

Ben-Zvi-Assaraf, O., & Orion, N. (2010). Four Case Studies, Six Years Later: Developing System Thinking Skills in Junior High School and Sustaining Them Over Time. *Journal of Research in Science Teaching*, *47*(10), 1253–1280. https://doi.org/10.1002/tea.20383

Benning, T. M. (2024). Reducing Free-Riding in Group Projects in Line With Students' Preferences: Does It Matter if There is More at Stake? *Active Learning in Higher Education*, *25*(2), 242–257. https://doi.org/10.1177/14697874221118864

Beroíza-Valenzuela, F., Salas-Guzmán, N., & Huepe, D. (2025). Bridging Gaps: The Role of Gender and Team Composition in Collective Intelligence within STEM Education. *Cogent Education*, *12*(1), 1–22. https://doi.org/10.1080/2331186X.2024.2439655

Bespalyy, S., Alnazarova, G., Scalcione, V. N., Vitliemov, P., Sichinava, A., Petrenko, A., & Kaptsov, A. (2024). Sustainable Development Awareness and Integration in Higher Education: A Comparative Analysis of Universities in Central Asia, South Caucasus and the EU. *Discover Sustainability*, *5*(346), 1–18. https://doi.org/10.1007/s43621-024-00562-2

Bian, C., Yang, L., Zhao, X., Yao, X., & Xiao, L. (2024). The Impact of Human Activity Expansion on Habitat Quality in the Yangtze River Basin. *Land*, *13*(7), 1–22. https://doi.org/10.3390/land13070908

Bielik, T., Krell, M., Zangori, L., & Ben Zvi Assaraf, O. (2023). Editorial: Investigating complex phenomena: bridging between systems thinking and modeling in science education. *Frontiers in Education*, *8*(1308241), 1–5. https://doi.org/10.3389/feduc.2023.1308241

Bilgin, C., & Gul, A. (2020). Investigating the Effectiveness of Gamification on Group Cohesion, Attitude, and Academic Achievement in Collaborative Learning Environments. *TechTrends*, *64*(1), 124–136. https://doi.org/10.1007/s11528-019-00442-x

Birdthistle, N., & Hales, R. (2023). *Family Businesses on a Mission: Attaining the 2030 Sustainable Development Goal of Responsible Consumption and Production*. Emerald Publishing Ltd.

Bodunde, K. J., Bello, S. A., & Olasunkanmi, L. (2024). Information Exchange and Collaborative Problem-Solving Roles in Organizational Conflict Resolution. *Journal of Management, Economics, and Industrial Organization*, *8*(3), 18–33. https://doi.org/10.31039/jomeino.2024.832

Bonilla, P., Armadans, I., & Anguera, M. T. (2024). Focus Group on Conflict Management in The Classroom in Secondary Education in Costa Rica: Mixed Methods Approach. *Frontiers in Psychology*, *15*(1407433), 1–17. https://doi.org/10.3389/fpsyg.2024.1407433

Boone, H. N. J., & Boone, D. A. (2012). Analyzing Likert Data. *Russian Chemical Bulletin*, *66*(8), 1456–1466. https://doi.org/10.1007/s11172-017-1908-3

Boud, D., & Bearman, M. (2022). The Assessment Challenge of Social and Collaborative Learning in Higher Education. *Educational Philosophy and Theory*, *56*(5), 459–468. https://doi.org/10.1080/00131857.2022.2114346

Bozkurt, N. O., & Bozkurt, E. (2024). Systems Thinking in Education: A Bibliometric Analysis. *Education and Sciences*, *49*(218), 1–27. https://doi.org/10.15390/EB.2024.12634

Budak, U. S., & Ceyhan, G. D. (2023). Research Trends on Systems Thinking Approach in Science Education. *International Journal of Science Education*, *46*(5), 485–502. https://doi.org/10.1080/09500693.2023.2245106

Burgess, S., Rawal, S., & Taylor, E. S. (2023). Teachers' Use of Class Time and Student Achievement. *Economics of Education Review*, *94*, 102405. https://doi.org/10.1016/j.econedurev.2023.102405

Burt, K. G., Luesse, H. B., Rakoff, J., Ventura, A., & Burgermaster, M. (2018). School Gardens in the United States: Current Barriers to Integration and Sustainability. *American Journal of Public Health*, *108*(11), 1543–1549. https://doi.org/10.2105/AJPH.2018.304674

Cabrera, D., & Cabrera, L. (2023). What is Systems Thinking? In *Learning, Design, and Technology* (pp. 1495–1522). Cham: Springer International Publishing. https://doi.org/10.4324/9781315412252-12

Çakmak, Z. (2023). Adapting to Environmental Change: The Importance of Organizational Agility in the Business Landscape. *Florya Chronicles of Political Economy*, *9*(1), 67–87. https://doi.org/10.17932/iau.fcpe.2015.010/fcpe_v09i1004

Cale, D., Franco, A., Ferreira, J. C., & Rocha, J. (2024). Gamification System for Eco-Driving: Enhancing Driver Motivation and Fuel Savings through Game Mechanics. *International Journal of Computer Information Systems and Industrial Management Applications*, *16*, 485–501. https://cspub-ijcisim.org/index.php/ijcisim/article/view/721

Camerman, E., Kuppens, P., Lavrijsen, J., & Verschueren, K. (2024). Real-Time Fluctuations in Student Emotions and Relations with Day of the Week, Time of the Day, and Teaching Methods. *Frontiers in Education*, *9*(1470565), 1–16. https://doi.org/10.3389/feduc.2024.1470565

Carnobell, E. O. (2023). *Permaculture: Contributing to Sustainable Development by Designing Resilient Communities* [University of Alicante]. https://doi.org/http://hdl.handle.net/10045/135482

Castillo, M., Heredia, Y., & Gallardo, K. (2017). Collaborative Work Competency in Online Postgraduate Students and Its Prevalence on Academic Achievement. *Turkish Online Journal of Distance Education*, *18*(3), 168–179. https://doi.org/10.17718/tojde.328949

Catasús, M. G., Romeu Fontanillas, T., Raffaghelli, J. E., & Cerro Martínez, J. P. (2025). Collaborative Learning Analytics: Centring the Ethical Implications Around Teacher and Student Empowerment. A Systematic Review. *Journal of Learning Analytics*, *12*(1), 201–214. https://doi.org/10.18608/jla.2025.8489

Chaidir, M., Sari Andini, Ulfa Hayana Sari Harahap, & Abdul Fattah Nasution. (2024). Peran dan Proses Berfikir Sistem dalam Konteks Pendidikan. *Student Research Journal*, *2*(6), 84–92. https://doi.org/10.55606/srj-yappi.v2i6.1629

Chakyarkandiyil, N., & Prakasha, G. S. (2023). Cooperative Learning Strategies: Implementation Challenges in Teacher Education. *Problems of Education in the 21st Century*, *81*(3), 340–360. https://doi.org/10.33225/pec/23.81.340

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, *20*(1), 1–18. https://doi.org/10.1186/s41239-023-00411-8

Chan, Clarke, D., & Cao, Y. (2017). The Social Essentials of Learning: An Experimental Investigation of Collaborative Problem Solving and Knowledge Construction in Mathematics Classrooms in Australia and China. *Mathematics Education Research Journal*, *30*(1), 39–50. https://doi.org/10.1007/s13394-017-0209-3

Chang, Y., & Brickman, P. (2018). When Group Work Doesn't Work: Insights from Students. *CBE Life Sciences Education*, *17*(3), 1–17. https://doi.org/10.1187/cbe.17-09-0199

Chen, C. C., & Tu, H. Y. (2021). The Effect of Digital Game-Based Learning on Learning Motivation and Performance Under Social Cognitive Theory and Entrepreneurial Thinking. *Frontiers in Psychology*, *12*(December). https://doi.org/10.3389/fpsyg.2021.750711

Chen, Wang, M., Grotzer, T. A., & Dede, C. (2024). Analysing Students' Concept Mapping Style and Its Association with Task Performance in Computer-Based Inquiry Learning. *Journal of Computer Assisted Learning*, *40*(4), 1727–1744. https://doi.org/10.1111/jcal.12984

Christensen, J. H., & Wistoft, K. (2019). Investigating the Effectiveness of Subject-Integrated School Garden Teaching. *Journal of Outdoor and Environmental Education*, *22*(3), 237–251. https://doi.org/10.1007/s42322-019-00043-5

Clark, M. A., Robertson, M. M., & Young, S. (2019). "I Feel Your Pain": A Critical Review of Organizational Research on Empathy. *Journal of Organizational Behavior*, *40*(2), 166–192. https://doi.org/10.1002/job.2348

Cooney, A., & Darcy, E. (2020). 'It was Fun': Exploring the Pedagogical Value of Collaborative Educational Games. *Journal of University Teaching & Learning Practice Volume*, *17*(3), 1–17. https://ro.uow.edu.au/jutlp/vol17/iss3/4

Couchman, C. (2018). *Urban Permaculture Designs for Optimizing Carbon Sequestration and Local Soil Health* [York University]. http://hdl.handle.net/10315/38874

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications, Inc. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Creswell, J. W., & Gutterman, T. C. (2019). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (Vol. 11, Issue 1). Pearson.

Cruz, E. F., Faria, P. M., Braga, D., & Assunc, D. (2024). Towards an Eco-Gamification Platform to Engage Consumers in the Textile & Clothing Circular Economy. *Proceedings of the 26th International Conference on Enterprise Information Systems (ICEIS 2024)*, *2*, 296–304. https://doi.org/10.5220/0012733300003690

D'Angelo, S. (2022). Building Resilience Now and for the Future: Adolescent Skills to Address Global Challenges. *Development Policy Review*, *40*(Suppl. 2), 1–9. https://doi.org/10.1111/dpr.12670

Deep, A., Pathan, R., & Mitra, R. (2018). Comparing Experts' Systems Thinking Skill Across Contexts. *Proceedings - IEEE 9th International Conference on Technology for Education, T4E 2018*, 154–157. https://doi.org/10.1109/T4E.2018.00041

Dekan, K. M. (2022). *A Localized Permaculture Education Model for Developmental Education in Addressing the Sustainability Development Goals*. University of Gothenburg. https://www.researchgate.net/publication/357575143%0AA

Demssie, Y. N., Biemans, H. J. A., & Wesselink, R. (2023). Fostering Students' Systems Thinking Competence for Sustainability by Using Multiple Real-World Learning Approaches. *Environmental Education Research*, *29*(2), 261–286. https://doi.org/10.1080/13504622.2022.2141692

Denis, M. J., & Umoh, S. A. (2024). Collaboration as an Effective Conflict Management Technique for Maximizing Classroom Productivity. *Journal of Graduate Education Research*, *5*, 41–47. https://doi.org/10.2139/ssrn.4742390

Deviane, A. (2019). *Permaculture as an Alternative Way of Living: The Example of Bumi Langit in Indonesia* [International Institute of Social Studies]. http://hdl.handle.net/2105/51314

Devin, S. R. (2021). Permaculture Design in Agriculture: A Review. *Advances in Agricultural Technology & Plant Sciences*, *4*(2), 1–10.

Dewey, B. I. (2020). The Power of Empathetic and Collaborative Leadership. *Library Leadership and Management*, *34*(2), 1–6. https://doi.org/10.5860/llm.v34i2.7427

Dimitra, K., Konstantinos, K., Christina, Z., & Katerina, T. (2020). Types of Game-Based Learning in Education: A brief state of the art and the implementation in Greece. *The European Educational Researcher*, *3*(2), 87–100. https://doi.org/10.31757/euer.324

Dinas Lingkungan Hidup Kota Bandung. (2022). *Laporan Kinerja Instansi Pemerintah*. Dinas Lingkungan Hidup Kota Bandung.

Dirgari, Y., Panjaitan, R. G. P., & Ary, K. (2023). Penerapan Problem Based Learning untuk Meningkatkan Motivasi Belajar Siswa pada Materi Ekosistem. *Jurnal Pendidikan Informatika Dan Sains*, *12*(1), 56–65. https://doi.org/10.31571/SAINTEK.V12I1.5688

Dmitrieva, I. A., & Yulmetova, R. F. (2021). Ecosystem Approach and Innovative Educational Ecosystems. *IOP Conference Series: Earth and Environmental Science*, 1–5. https://doi.org/10.1088/1755-1315/864/1/012002

Donelan, H., & Kear, K. (2024). Online Group Projects in Higher Education: Persistent Challenges and Implications for Practice. In *Journal of Computing in Higher Education* (Vol. 36, Issue 2). Springer US. https://doi.org/10.1007/s12528-023-09360-7

Droste, N., D'Amato, D., & Jessica, J. G. (2018). Where Communities Intermingle, Diversity Grows – The Evolution of Topics in Ecosystem Service Research. *PLoS ONE*, *13*(9), 1–19. https://doi.org/10.1371/journal.pone.0204749

Düker, J., & Rieber, A. (2024). Performance, Knowledge Acquisition and Satisfaction in Self-selected Groups: Evidence from a Classroom Field Experiment. *Economics*, 1–39. https://doi.org/10.48550/arXiv.2403.12694

Effendi, Q. N. A., Listiawati, M., & Yusup, I. R. (2023). Keterampilan Berpikir Sistem Menggunakan Model Discovery Learning pada Materi Sistem Gerak Manusia. *Jurnal Bioedutech: JURNAL BIOLOGI, PENDIDIKAN BIOLOGI, DAN TEKNOLOGI KESEHATAN*, *2*(2), 11–24. https://doi.org/10.572349/biedutech.v2i2.1363

Egan, C., Egan, C., Thompson, R., & Dowd, A. O. (2019). The Lions' Gate towards a Permaculture-Inspired Blended Space. *Proceedings of the Fifth Workshop on Computing within Limits*, *June*, 1–8. https://doi.org/10.1145/3338103.3338110

Eiselen, R., & Huyssteen, G. B. (2023). A Comparison of Statistical Tests for Likert-Type Data: The Case of Swearwords. *Journal of Open Humanities Data*, *9*(18), 1–13. https://doi.org/10.5334/JOHD.132

Ekizer, F. N., & Yildirim, S. S. (2023). 21st Century Skills and Learning Environments: ELT Students Perceptions. *Educational Research and Reviews*, *18*(6), 114–128. https://doi.org/10.5897/err2023.4332

Ekselsa, R. A., Purwianingsih, W., Sri, A., & Azizul, G. C. W. (2023). Developing System Thinking Skills through Project-Based Learning Loaded with Education for Sustainable Development. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *9*(1), 62–73. https://doi.org/10.22219/jpbi.v9i1.24261

Eldridge, S., Francois, K., Erin, H., & Keely, S. A. (2023). *Integration of Food Systems and School Gardens into Michigan K-12 Education*. University of Michigan.

Elmassah, S., Mostafa Bacheer, S., & James, R. (2020). What Shapes Students' Perceptions of Group Work: Personality or Past Experience? *International Journal of Educational Management*, *34*(9), 1457–1473. https://doi.org/10.1108/IJEM-11-2019-0401

Elzeky, M. E. H., Elhabashy, H. M. M., Ali, W. G. M., & Allam, S. M. E. (2022).

Effect of Gamified Flipped Classroom on Improving Nursing Students' Skills Competency and Learning Motivation: A Randomized Controlled Trial. *BMC Nursing*, *21*(1), 1–13. https://doi.org/10.1186/s12912-022-01096-6

Eshuis, E. H., ter Vrugte, J., Anjewierden, A., Bollen, L., Sikken, J., & de Jong, T. (2019). Improving the Quality of Vocational Students' Collaboration and Knowledge Acquisition through Instruction and Joint Reflection. *International Journal of Computer-Supported Collaborative Learning*, *14*(1), 53–76. https://doi.org/10.1007/s11412-019-09296-0

Evans, C. (2020). *Measuring Student Success Skills: A Review of the Literature on Collaboration* (Issue May). National Center for the Improvement of Educational Assessment. https://files.eric.ed.gov/fulltext/ED607774.pdf

Fadaee, S. (2019). The Permaculture Movement in India: A Social Movement with Southern Characteristics. *Social Movement Studies*, *18*(6), 720–734. https://doi.org/10.1080/14742837.2019.1628732

Falzon, D., & Conrad, E. (2024). Designing Primary School Grounds for Nature-Based Learning: A Review of the Evidence. In *Journal of Outdoor and Environmental Education* (Vol. 27, Issue 3). Springer Nature Singapore. https://doi.org/10.1007/s42322-023-00142-4

Feirsen, R., & Weitzman, S. (2023). Conflict-Competent Leadership. *Phi Delta Kappan*, *105*(4), 37–41. https://doi.org/10.1177/00317217231219403

Feng, Q., Luo, H., Li, W., Chen, T., & Song, N. (2023). Effects of Gender Diversity on College Students' Collaborative Learning: From Individual Gender to Gender Pairing. *Heliyon*, *9*(6), 1–14. https://doi.org/10.1016/j.heliyon.2023.e16237

Ferguson, R. S., & Lovell, S. T. (2014). Permaculture for Agroecology: Design, Movement, Practice, and Worldview. A review. *Agronomy for Sustainable Development*, *34*(2), 251–274. https://doi.org/10.1007/s13593-013-0181-6

Fernández, D. C., Gómez-Gonçalves, A., González, S. S., & Rodríguez, J. M. M. (2025). Connectedness to Nature: Assessing The Impact of Garden-Based Learning on Teacher Education. *Journal of Outdoor and Environmental Education*, 1–18. https://doi.org/10.1007/s42322-025-00201-y

Fiebrig, I., Zikeli, S., Bach, S., & Gruber, S. (2020). Perspectives on Permaculture for Commercial Farming: Aspirations and Realities. *Organic Agriculture*, *10*, 379–394. https://doi.org/10.1007/s13165-020-00281-8 Perspectives

Fiore, A. M., Graesser, A., Samuel, G., Patrick, G., Brian, G., Patrick, K., Christine, M., Harry, O., Jim, P., & Robert, R. (2017). *Collaborative Problem Solving: Considerations for the National Assessment of Educational Progress*. National

Center for Education Statistics. http://hdl.handle.net/10993/31897

Firman, Nur, S., & Taim, M. A. S. L. (2023). Analisis Keterampilan Kolaborasi Siswa SMA pada Pembelajaran Biologi. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, *7*(1), 82–89. https://doi.org/10.33369/diklabio.7.1.82-89

Flournoy, E. L., & Bauman, L. C. (2021). The Canadian Journal for the Scholarship of Teaching and Learning Collaborative Assessment: Using Self-assessment and Reflection for Student Learning and Program Development. *The Canadian Journal for the Scholarship of Teaching and Learning*, *12*(1), 1–21. https://doi.org/10.5206/cjsotl-rcacea.2021.1.14207

Fonseca, A. P., & Zegers, C. (2024). Collaborative Learning Ecosystems: Enhancing Communities of Practice in Digital Spaces. *International Journal of Strategy and Organisational Learning*, *1*(2), 37–55. https://doi.org/10.56830/IJSOL12202405

Forsell, J., Forslund Frykedal, K., & Chiriac, E. H. (2021). Teachers' Perceived Challenges in Group Work Assessment. *Cogent Education*, *8*(1), 1–16. https://doi.org/10.1080/2331186X.2021.1886474

Fotaris, P., & Mastoras, T. (2022). Room2Educ8: A Conceptual Framework for Designing Educational Escape Rooms. *Proceedings of the European Conference on Games-Based Learning*, *2022*(October), 693–701.

Fraenkel, J. R., Wallen, N., & Helen, H. H. (2023). How to Design and Evaluate Research in Education. In *McGraw-Hill Higher Education* (Eleventh E). McGraw-Hill Education.

Fuller, M., Kamans, E., van Vuuren, M., Wolfensberger, M., & de Jong, M. D. T. (2021). Conceptualizing Empathy Competence: A Professional Communication Perspective. *Journal of Business and Technical Communication*, *35*(3), 333–368. https://doi.org/10.1177/10506519211001125

Fung, D. (2023). The Synergy of Peer Collaboration and Mind Mapping in Cultivating Primary Students' Science Understanding: An Integrative Pedagogy to Enhance Science Concept Acquisition. *International Journal of Science Education*, *46*(2), 131–154. https://doi.org/10.1080/09500693.2023.2222549

Gaad, A. L. V. (2022). The Effects of Online Collaborative Learning (OCL) on Student Achievement and Engagement. *IAFOR Journal of Education*, *10*(3), 31–48. https://doi.org/10.22492/ije.10.3.02

Gallardo-Vázquez, D., Severino-González, P., Tunjo-Buitrago, E., Sarmiento-

Peralta, G., & Romero-Argueta, J. (2024). Empathy and Solidarity as a Bridge between Sustainable Development Goals and Strategic Management of Higher Education Institutions. *Oeconomia Copernicana*, *15*(3), 925–956. https://doi.org/10.24136/oc.2975

Gatti, L., Ulrich, M., & Seele, P. (2019). Education for Sustainable Development through Business Simulation Games: An Exploratory Study of Sustainability Gamification and Its Effects on Students' Learning Outcomes. *Journal of Cleaner Production*, *207*, 667–678. https://doi.org/10.1016/j.jclepro.2018.09.130

Ghanbari, S., Mahdavinasab, Y., Nasrin, M., & Sayed, A. G. (2024). The Effect of Gamification and Uncertainty in Rewards on Elementary School Students: A Quasi-Experimental Study. *Interdisciplinary Journal of Virtual Learning in Medical Sciences*, *15*(2), 1–12. https://doi.org/10.30476/ijvlms.2024.97294.1197

Gilissen, M. G. R., Knippels, M. C. P. J., & van Joolingen, W. R. (2020). Bringing Systems Thinking into the Classroom. *International Journal of Science Education*, *42*(8), 1253–1280. https://doi.org/10.1080/09500693.2020.1755741

Gilissen, M. G. R., Knippels, M. C. P. J., & van Joolingen, W. R. (2021). Fostering Students' Understanding of Complex Biological Systems. *CBE Life Sciences Education*, *20*(3), 1–15. https://doi.org/10.1187/cbe.20-05-0088

Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education*, *41*(3), 39–54. https://doi.org/10.14221/ajte.2016v41n3.3

Ginzburg, A. L., Check, C. E., Hovekamp, D. P., Sillin, A. N., Brett, J., Eshelman, H., & Hutchison, J. E. (2019). Experiential Learning to Promote Systems Thinking in Chemistry: Evaluating and Designing Sustainable Products in a Polymer Immersion Lab. *Journal of Chemical Education*, *96*(12), 2863–2871. https://doi.org/10.1021/acs.jchemed.9b00336

Goddek, S., Joyce, A., & Benz, K. (2019). *Aquaponics Food Production Systems: Combined Aquaculture and Hydroponic Production Technologies for the Future*. Springer Nature. https://doi.org/10.1007/978-3-030-15943-6

González-Salamanca, J. C., Agudelo, O. L., & Salinas, J. (2020). Key Competences, Education for Sustainable Development and Strategies for The Development of 21st Century Skills. A Systematic Literature Review. *Sustainability (Switzerland)*, *12*(24), 1–17. https://doi.org/10.3390/su122410366

Goode, G. S., & Macgillivray, L. (2023). The Construction of Systems Thinking

Pedagogy during a Professional Development Institute. *Journal of Pedagogical Research*, *7*(4), 275–302. https://doi.org/10.33902/JPR.202318879

Grace, L. D. (2020). *Doing Things with Games Social Impact Through Play*. Taylor & Francis Group. https://doi.org/10.1201/9780429429880

Graesser, C. A., Foltz, P. W., Rosen, Y., Shaffer, D. W., Forsyth, C., & Germany, M.-L. (2018). Challenges of Assessing Collaborative Problem Solving. In *Assessment and Teaching of 21st Century Skills, Educational Assessment in an Information Age* (pp. 75–91). Springer International Publishing. https://doi.org/10.1007/978-3-319-65368-6_5

Grenyer, A., Schwabe, O., Erkoyuncu, J. A., & Zhao, Y. (2022). Multistep Prediction of Dynamic Uncertainty Under Limited Data. *CIRP Journal of Manufacturing Science and Technology*, *37*, 37–54. https://doi.org/10.1016/j.cirpj.2022.01.002

Grohs, J. R., Kirk, G. R., Soledad, M. M., & Knight, D. B. (2018). Assessing Systems Thinking: A Tool to Measure Complex Reasoning through Ill-Structured Problems. *Thinking Skills and Creativity*, *28*(9), 110–130. https://doi.org/10.1016/j.tsc.2018.03.003

Gusta, W., Christina, D., & Zakirman. (2020). Improved Student Collaboration Skills on English Learning Using Jigsaw Models. *International Journal of Scientific & Technology Research*, *9*(03), 1051–1056. http://repository.upiyptk.ac.id/id/eprint/3107

Haas, A., Grapin, S. E., Wendel, D., Llosa, L., & Lee, O. (2020). How Fifth-Grade English Learners Engage in Systems Thinking Using Computational Models. *Systems*, *8*(4), 1–17. https://doi.org/10.3390/systems8040047

Hake, R. R. (1998). Interactive-Engagement Versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Hamzah, A. H. P. (2023). The Influence of Natural Environment Usage on Student. *MUDIR: Jurnal Manajemen Pendidikan*, *5*(1), 1–5. https://doi.org/10.55352/mudir.v5i1.41

Hanida, J. R., Rachmadiarti, F., & Endang, S. (2023). Pengembangan E-Modul Pembelajaran Ekosistem Berbasis Masalah. *Jurnal Inovasi Pembelajaran Biologi*, *4*(1), 22–38. https://doi.org/10.26740/jipb.v4n1.p23-38

Hariyastuti, A., Wardani, S., Raharjo, T. J., Subali, B., & Widiarti, N. (2024). Flipbook Food Chain in an Ecosystem to Improve Learning Outcomes in

Elementary School. *Jurnal Ilmiah Pendidikan Dasar*, *11*(2), 204–218. https://doi.org/10.30659/pendas.11.2.204-218

Harris, C. L., Brummitt, N., Cobbold, C. A., & Reeve, R. (2019). Dynamic Virtual Ecosystems as a Tool for Detecting Large-Scale Responses of Biodiversity to Environmental and Land-Use Change. *Cornell University*, *1*(1), 1–28. http://arxiv.org/abs/1911.12257

Hartmann, A., Vinke-de Kruijf, J., & van Weesep, R. (2023). Asking the Right Questions: The Role of Reflection for Learning in and Between Projects. *International Journal of Project Management*, *41*(5), 1–13. https://doi.org/10.1016/j.ijproman.2023.102494

Hartmann, Olsen, J. K., Brand, C., Aleven, V., & Rummel, N. (2017). Examining Positive and Negative Interdependence in an Elementary School CSCL Setting. *The 12th International Conference on Computer Supported Collaborative Learning*, *2*, 633–636.

Haryono, H. E., Hidayah, N., Mubarokah, A., & Prihaningtyas, S. (2024). Effectiveness of Collaborative E-Learning Model in Reducing High School Students' Misconceptions on Heat. *Science Education Journal (SEJ)*, *8*(2), 165–175. https://doi.org/10.21070/sej.v8i2.1657

Hasanah, E., Al Badar, M. I., Al Ghazy, M. I., & Fauzia, F. (2023). Enhancing Student Leadership Skills through Project-Based Learning in the Postgraduate Research Experience. *The Qualitative Report*, *28*(5), 1406–1428. https://doi.org/10.46743/2160-3715/2023.5848

Hastika, A. D., Saefudin, & Supriatno, B. (2024). Exploring Students' Perceptions of Outdoor Biology Learning Activities in Botanical Garden. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2379–2387. https://doi.org/10.29303/jppipa.v10i5.6718

Havita, V. N., Hamidah, I., & Siti, S. (2021). Education Sustainable Development-Integrated Organic Waste Management to Improve Students Sustainability Literacy. *Jurnal Pendidikan MIPA*, *22*(2), 723–731. https://doi.org/10.23960/jpmipa/v22i2.pp262-269

Hecht, M., & Crowley, K. (2019). Unpacking the Learning Ecosystems Framework: Lessons from the Adaptive Management of Biological Ecosystems. *Journal of Learning Sciencec*, *29*(2), 1–21. https://doi.org/10.1080/10508406.2019.1693381

Hemenwey, T. (2009). Gaia's Garden: A Guide to Home-Scale Permaculture. In *Etika Jurnalisme Pada Koran Kuning : Sebuah Studi Mengenai Koran Lampu Hijau* (Vol. 16, Issue 2). Chelsea Green Publishing.

Herlinawati, H., Marwa, M., Ismail, N., Liza, O., David, D., & Situmorang, B. (2024). Heliyon The integration of 21st Century Skills in the Curriculum of Education. *Heliyon*, *10*, 1–11. https://doi.org/10.1016/j.heliyon.2024.e35148

Hidayati, N. (2019). Collaboration Skill Of Biology Students At Universitas Islam Riau, Indonesia. *International Journal of Scientific & Technology Research*, *8*(11), 208–211. https://repository.uir.ac.id/id/eprint/2057

Hidayati, N., Sugiharto, B., & Maridi. (2021). Teacher Assessment Profile of Student Collaboration Skill in Science and Biology Learning. *Proceeding Biology Education Conference*, *17*(1), 98–106.

Hidayatullah, R. S., Ariyanto, S. R., Muhaji, Mubarok, H., & Yohannes, A. (2020). Collaborative Problem-based Learning: An Analysis of Problem-Solving Skills in Vocational Schools. *IJORER : International Journal of Recent Educational Research*, *1*(3), 209–217. https://doi.org/10.46245/ijorer.v1i3.62

Hirschfeld, S., & Van Acker, R. (2021). Review: Ecosystem Services in Permaculture Systems. *Agroecology and Sustainable Food Systems*, *45*(6), 794–816. https://doi.org/10.1080/21683565.2021.1881862

Hmelo-Silver, C. E., Jordan, R., Eberbach, C., & Sinha, S. (2017). Systems Learning with A Conceptual Representation: A Quasi-Experimental Study. *Instructional Science*, *45*(1), 53–72. https://doi.org/10.1007/s11251-016-9392-y

Hockin-Grant, K. J., & Yasué, M. (2017). The Effectiveness of A Permaculture Education Project in Butula, Kenya. *International Journal of Agricultural Sustainability*, *15*(4), 432–444. https://doi.org/10.1080/14735903.2017.1335570

Holmgren, D. (2011). *Permaculture: Principles & Pathways Beyond Sustainability*. Permanent Publication.

Hong, W., Ke, D., Chuan, Z., Xianglan, L., & Guoqing, L. (2022). Permaculture Inclusion in the Planning of "Sansheng Space" - Taking Pu Ran Farm as an Example. *The 5th International Workshop on Environment and Geoscience*, 1–7. https://doi.org/10.1088/1755-1315/1087/1/012051

Hossain, N. U. I., Dayarathna, V. L., Nagahi, M., & Jaradat, R. (2020). Systems Thinking: A Review and Bibliometric Analysis. *Systems*, *8*(3), 1–26. https://doi.org/10.3390/systems8030023

Hu, Y. Z., Wei, H. T., & Mark, C. (2023). Computers in Human Behavior Impact of Rewards on Cognitive Game performance: Competition with Peers Increases Enjoyment in Easy, but not Difficult Tasks. *Computers in Human Behavior*, *149*(107952), 1–17. https://doi.org/10.1016/j.chb.2023.107952

Huang, B., Hwang, G. J., Hew, K. F., & Warning, P. (2019). Effects of Gamification on Students' Online Interactive Patterns and Peer-Feedback. *Distance Education*, *40*(3), 350–379. https://doi.org/10.1080/01587919.2019.1632168

Huang, & Lajoie, S. P. (2023). Social emotional interaction in collaborative learning: Why it matters and how can we measure it? *Social Sciences and Humanities Open*, *7*(100447), 1–9. https://doi.org/10.1016/j.ssaho.2023.100447

Huelskamp, A. C. (2018). Enhancing the Health of School Garden Programs and Youth: A Systematic Review. *The Health Educator*, *50*(1), 11–23. https://eric.ed.gov/?id=EJ1196093

Husin, A., Helmi, H., Nengsih, Y. K., & Rendana, M. (2025). Environmental Education in Schools: Sustainability and Hope. *Discover Sustainability*, *6*(1), 1–11. https://doi.org/10.1007/s43621-025-00837-2

Hutagaol, K. J. A., & Halim, M. (2021). Pabrik Gasifikasi Berbasis Edukasi dan Rekreasi Air sebagai Solusi Pencemaran Sampah Plastik Sungai Citarum Kabupaten Bandung. *Jurnal STUPA: Sains, Teknologi, Urban, Perancangan, Arsitektur*, *3*(2), 2333–2346. https://doi.org/10.24912/stupa.v3i2.12327

Hwang, G. J., & Chen, P. Y. (2022). Interweaving Gaming and Educational Technologies: Clustering and Forecasting The Trends of Game-Based Learning Research by Bibliometric and Visual Analysis. *Entertainment Computing*, *40*(43), 1–11. https://doi.org/10.1016/j.entcom.2021.100459

Idris, S. (2023). Mindset Kurikulum Merdeka. *Sustainable Jurnal Kajian Mutu Pendidikan*, *6*(2), 482–492. https://doi.org/10.32923/kjmp.v6i2.3993

Ilham, M. I. (2021). Economic Development and Environmental Degradation in Indonesia: Panel Data Analysis. *Jurnal Ekonomi Dan Studi Pembangunan*, *22*(2), 185–200. https://doi.org/10.18196/jesp.v22i2.7629

Ilhamdi, M. L., Idrus, A. Al, Jufri, A. W., Santoso, D., & Mertha, I. W. (2021). Pelatihan Pengelolaan Sampah di Lingkungan Kampus FKIP Unram Menggunakan Bioteknologi EM4 (Effective Microorganism 4) menjadi Pupuk Bokashi. *Jurnal Pengabdian Magister Pendidikan IPA*, *4*(4), 76–81. https://doi.org/10.29303/jpmpi.v4i4.1027

Jääskä, E., & Aaltonen, K. (2022). Teachers' experiences of using game-based learning methods in project management higher education. *Project Leadership and Society*, *3*(100041), 1–12. https://doi.org/10.1016/j.plas.2022.100041

Jasper, J., Judy, J., Gus, G., Jiang, W., & Walters, G. (2024). Journal of Hospitality and Tourism Management Not just a game : Understanding eco-gamification in sustainable destination development. *Journal of Hospitality and Tourism*

Management, *60*(January), 10–21. https://doi.org/10.1016/j.jhtm.2024.06.005

Jayadi, A., Putri, D. H., & Johan, H. (2020). Identifikasi Pembekalan Keterampilan Abad 21 pada Aspek Keterampilan Pemecahan Masalah Siswa SMA Kota Bengkulu dalam Mata Pelajaran Fisika. *Jurnal Kumparan Fisika*, *3*(1), 25–32. https://doi.org/10.33369/jkf.3.1.25-32

Jeanne, C. K. (2024). *Penerapan Konsep Permakultur dalam Mewujudkan Perancangan Sekolah Alam pada Kawasan Tandon Lengkong Karya, Tangerang Selatan* [Universitas Multimedia Nusantara]. https://kc.umn.ac.id/id/eprint/33821/

Jin, H., Shin, H. J., & Hokayem, H. (2019). Secondary Students ' Understanding of Ecosystems : A Learning Progression Approach. *International Journal of Science and Mathematics Education*, *17*, 217–235. https://doi.org/10.1007/s10763-017-9864-9

Johariah, Jalmo, T., & Lengkana, D. (2023). Pengembangan Instrumen Penilaian Untuk Mengukur Kemampuan Berpikir Sistem Siswa SMP Pada Materi Pencemaran Lingkungan System thinking atau berpikir sistem adalah salah satu kemampuan yang sangat terlepas dari penilaian hasil belajar . Karena orang guru IP. *Jurnal Pendidikan Mandala*, *8*(1), 374–382.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and Research*. Interaction Book Company.

Johnson, D. W., & Johnson, R. T. (2009). An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning. *Educational Researcher*, *38*(5), 365–379. https://doi.org/10.3102/0013189X09339057

Junge, R., König, B., Villarroel, M., Komives, T., & Jijakli, M. H. (2017). Strategic Points in Aquaponics. *Water (Switzerland)*, *9*(3), 1–9. https://doi.org/10.3390/w9030182

Kailani, S., Newton, R., & Pedersen, S. (2019). Game-Based Learning and Problem-solving Skills: A Systematic Review of the Literature. *Proceedings of EdMedia & Innovate Learning*, *1*(1), 1127–1137. https://www.learntechlib.org/p/210119/

Kan, J. (2024). Research on the Relationship between Leadership Style and Team Dynamics in High-Performance Teams. *SHS Web of Conferences*, *200*, 1–4. https://doi.org/10.1051/shsconf/202420002031

Keusters, G., Hertogh, M., Bakker, H., & Houwing, E. J. (2024). Empathic Ability as a Driver for Project Management. *International Journal of Project Management*, *42*(4), 1–12. https://doi.org/10.1016/j.ijproman.2024.102591

Kim, M. K., Lee, I. H., & Wang, Y. (2020). How Students Emerge as Learning Leaders in Small Group Online Discussions. *Journal of Computer Assisted Learning*, *36*(5), 610–624. https://doi.org/10.1111/jcal.12431

Kiviranta, L., Lindfors, E., Rönkkö, M. L., & Luukka, E. (2024). Outdoor Learning in Early Childhood Education: Exploring Benefits and Challenges. *Educational Research*, *66*(1), 102–119. https://doi.org/10.1080/00131881.2023.2285762

Kock, N., Mayfield, M., Mayfield, J., Sexton, S., & De La Garza, L. M. (2019). Empathetic Leadership: How Leader Emotional Support and Understanding Influences Follower Performance. *Journal of Leadership and Organizational Studies*, *26*(2), 217–236. https://doi.org/10.1177/1548051818806290

Kong, C., & Chen, J. (2024). School Garden and Instructional Interventions Foster Children's Interest in Nature. *People and Nature*, *6*(2), 712–732. https://doi.org/10.1002/pan3.10597

Kordova, S. (2020). Developing Systems Thinking in a Project-Based Learning Environment. *International Journal of Engineering Education*, *2*(1), 63–81. https://doi.org/10.14710/ijee.2.1.63-81

Kourayem, F. T., & Ghadim, M. K. (2021). A Review of System Thinking and Wise Organization. *New Applied Studies in Management, Economics & Accounting*, *4*(3), 7–23. https://doi.org/10.22034/nasmea.2021.176216

Kovaric, K., & Gingell, G. (2024). Effects of an Experiential Learning Curriculum on Systems-Thinking. *Journal of Medical Education and Curricular Development*, *11*, 1–8. https://doi.org/10.1177/23821205241262210

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the Theoretical Basis of Gamification: A Systematic Review and Analysis of Theory in Research on Gamification, Serious Games and Game-Based Learning. *Computers in Human Behavior*, *125*, 1–33. https://doi.org/10.1016/j.chb.2021.106963

Krebs, J., & Bach, S. (2018). Permaculture — Scientific Evidence of Principles for the Agroecological Design of Farming Systems. *Sustainability*, *10*(3218), 1–24. https://doi.org/10.3390/su10093218

Krisdianti, N. R., Puspaningsih, E. T., & Tjahjadarmawan, E. (2023). *Ilmu Pengetahuan Alam: Panduan Guru Edisi Revisi*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.

Kumar, T., Soozandehfar, S. M. A., Hashemifardnia, A., & Mombeini, R. (2023). Self vs. Peer Assessment Activities in EFL-Speaking Classes: Impacts on Students' Self-Regulated Learning, Critical Thinking, and Problem-Solving

Skills. *Language Testing in Asia*, *13*(36), 1–22. https://doi.org/10.1186/s40468-023-00251-3

Kunwar, J. B. (2021). The Influence of Culture on Collaborative Learning Practices in Higher Education. *Journal of Intercultural Management*, *13*(2), 81–106. https://doi.org/10.2478/joim-2021-0062

Kurent, B., & Avsec, S. (2024). Synergizing Systems Thinking and Technology-Enhanced Learning for Sustainable Education Using the Flow Theory Framework. *Sustainability (Switzerland)*, *16*(21), 1–40. https://doi.org/10.3390/su16219319

Kurnia, N., Baharuddin, R., Ngitung, R., & Auliah, A. (2018). Lalat Hijau Lucilia sericata sebagai Agen Biokonversi Sampah Organik: Pengamatan Siklus Hidup Green Fly (Lucilia sericata) as a Bioconversion Agent for Organic Waste: Life Cycle Observation. *Prosiding Seminar Nasional Biologi Dan Pembelajarannya Inovasi Pembelajaran Dan Penelitian Biologi Berbasis Potensi Alam*, 599–606. https://ojs.unm.ac.id/semnasbio/article/view/7969

Kusumarti, D. G., Sariyatun, & Triana, R. (2024). The Evolution of Collaboration Skills Research in Education: Trends, Intellectual Structure, and Research Topics. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *10*(2), 728–739. https://doi.org/10.33394/jk.v10i2.11664

Laar, E. Van, Deursen, A. J. A. M. Van, Dijk, J. A. G. M. Van, & Haan, J. De. (2020). Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers : A Systematic Literature Review. *SAGE Open*, *10*(1), 1–14. https://doi.org/10.1177/2158244019900176

Lankers, A., Timm, J., & Schmiemann, P. (2023). Students' Systems Thinking while Modeling a Dynamic Ecological System. *Frontiers in Education*, *8*(7), 1–14. https://doi.org/10.3389/feduc.2023.1187237

Lappas, D., Kottis, G., & Karampelas, P. (2023). Using Game-Based Learning To Enhance Decision Making Under Uncertainty. *International Journal of Film and Media Arts*, *8*(1), 36–51. https://doi.org/10.24140/ijfma.v8.n1.02

Le, H., Janssen, J., & Wubbels, T. (2017). Collaborative Learning Practices: Teacher and Student Perceived Obstacles to Effective Student Collaboration. *Cambridge Journal of Education*, *48*(1), 103–122. https://doi.org/10.1080/0305764X.2016.1259389

Lebron, M., Swab, R. G., & Bruns, R. (2023). Students as Game Designers and Developers: Developing Cooperative Strategy Board Games to Teach Team Leadership Skills. *Organization Management Journal*, *21*(1), 41–48. https://doi.org/10.1108/OMJ-03-2023-1783

Leek, J., Rojek, M., Dobińska, G., & Kosiorek, M. (2024). Navigating the Power of Time in Classroom Practices: Teachers' and Students' Perspectives. *Educational Review*, 1–23. https://doi.org/10.1080/00131911.2024.2438878

Leicht, A., Heiss, J., & Byun, W. J. (2018). *Issues and Trends in Education for Sustainable Development*. UNESCO Publishing. https://doi.org/10.54675/yelo2332

Leitão, R., Maguire, M., Turner, S., & Guimarães, L. (2021). A Systematic Evaluation of Game Elements Effects on Students' Motivation. *Education and Information Technologies*, *27*, 1081–1103. https://doi.org/10.1007/s10639-021-10651-8

Leni-Konig, K. (2019). *Beyond School Gardens: Permaculture Food Forests Enhance Ecosystem Services While Achieving Education for Sustainable Development Goals* (Issue March) [Harvard University]. https://www.mendeley.com/catalogue/0d7187a9-8f6d-34c3-bbbb-d2b17072436f/?utm_source=desktop&utm_medium=1.19.8&utm_campaign=open_catalog&userDocumentId=%7Bfedfc599-1d3f-4429-99b3-fb9fa1b46367%7D

Lerchenfeldt, S., Mi, M., & Eng, M. (2019). The Utilization of Peer Feedback during Collaborative Learning in Undergraduate Medical Education: A Systematic Review. *BMC Medical Education*, *19*(1), 1–10. https://doi.org/10.1186/s12909-019-1755-z

Leskinen, J., Kumpulainen, K., Kajamaa, A., & Rajala, A. (2022). The Emergence of Leadership in Students' Group Interaction in a School-Based Makerspace. *European Journal of Psychology of Education*, *36*(4), 1033–1053. https://doi.org/10.1007/s10212-020-00509-x

Li, M. (2023a). Designing Co-Curriculum Experiential Learning Practice in Permaculture for Studying Science Classics. *9th International Conference on Higher Education Advances (HEAd'23)*, 843–850. https://doi.org/10.4995/HEAd23.2023.16365

Li, M. (2023b). Designing Co-Curriculum Experiential Learning Practice in Permaculture for Studying Science Classics. *9th International Conference on Higher Education Advances (HEAd'23)*, 843–850. https://doi.org/10.4995/HEAd23.2023.16365

Li, M., Ma, S., & Shi, Y. (2023). Examining The Effectiveness of Gamification as a Tool Promoting Teaching and Learning in Educational Settings: A Meta-Analysis. *Frontiers in Psychology*, *14*(10), 1–17. https://doi.org/10.3389/fpsyg.2023.1253549

Lilburne, L., Robson-Williams, M., & Norton, N. (2022). Improving Understanding

and Management of Uncertainty in Science-Informed Collaborative Policy Processes. *Sustainability (Switzerland)*, *14*(10), 1–23. https://doi.org/10.3390/su14106041

Lin, C., Lin, X., Weicheng, L., Wenting, Z., & Weiwei, P. (2024). Brain in Sync, Friends in Empathy: Interbrain Neural Mechanisms Underlying the Impact of Interpersonal Closeness on Mutual Empathy. *Proceedings of The Royal Society B*, 1–3. https://doi.org/10.6084/m9.figshare.c.7437383

Lin, Wu, C. C., Chen, Z. H., & Ku, P. Y. (2020). *How Gender Pairings Affect Collaborative Problem Solving in Social- Learning Context : The Effects on Performance , Behaviors , and Attitudes*. *23*, 30–44. https://eric.ed.gov/?id=EJ1279459

Linnéusson, G., Andersson, T., Kjellsdotter, A., & Holmén, M. (2022). Using Systems Thinking to Increase Understanding of The Innovation System of Healthcare Organisations. *Journal of Health Organization and Management*, *36*(9), 179–195. https://doi.org/10.1108/JHOM-01-2022-0004

Luna, M., Dávila, E. R., Luna, J. M., Dávila, E. R., & Reynoso-morris, A. (2018). Pedagogy of Permaculture and Food Justice. *The Journal of Educational Foundations*, *31*(1), 59–87. https://eric.ed.gov/?id=EJ1193673

Luo, H., Han, X., Chen, Y., & Nie, Y. (2022). Should You Become a Leader in Online Collaborative Learning? Impact of Assigned Leadership on Learning Behaviors, Outcomes, and Perceptions. *PLoS ONE*, *17*(4), 1–16. https://doi.org/10.1371/journal.pone.0266653

Lutz, S., Frey, A., Rank, A., & Gebhardt, M. (2024). Inclass – an Instrument to Assess Classroom Management in Inclusive and Special Education with a Focus on Heterogeneous Learning Groups. *Frontiers in Education*, *9*(2), 1–10. https://doi.org/10.3389/feduc.2024.1316059

Lykourentzou, I., Vinella, F. L., Ahmed, F., Papastathis, C., Papangelis, K., Khan, V.-J., & Masthoff, J. (2021). Self-Organizing Teams in Online Work Settings. *Collective Intelligence*, *1*(1), 1–39. https://doi.org/10.1145/1122445.1122456

Ma, B., Stirling, E., Liu, Y., Zhao, K., Zhou, J., Singh, B. K., Tang, C., Dahlgren, R. A., & Xu, J. (2021). Soil Biogeochemical Cycle Couplings Inferred from a Function-Taxon Network. *Research: A Science Paper Journal*, *2021*, 1–10. https://doi.org/10.34133/2021/7102769

Magana, A. J., Amuah, T., Aggrawal, S., & Patel, D. A. (2023). Teamwork Dynamics in The Context of Large-Size Software Development Courses. *International Journal of STEM Education*, *10*(57), 1–16. https://doi.org/10.1186/s40594-023-00451-6

Mahmood, S., Zurbrügg, C., Tabinda, A. B., Ali, A., & Ashraf, A. (2021). Sustainable Waste Management at Household Level with Black Soldier Fly Larvae (Hermetia Illucens). *Sustainability (Switzerland)*, *13*(17), 1–18. https://doi.org/10.3390/su13179722

Mambrey, S., Schreiber, N., & Philipp, S. (2022). Young Students' Reasoning About Ecosystems: The Role of Systems Thinking, Knowledge, Conceptions, and Representation. *Research in Science Education*, *52*, 79–98. https://doi.org/10.1007/s11165-020-09917-x

Mann, J., Gray, T., Truong, S., Brymer, E., Passy, R., Ho, S., Sahlberg, P., Ward, K., Bentsen, P., Curry, C., & Cowper, R. (2022). Getting Out of the Classroom and Into Nature: A Systematic Review of Nature-Specific Outdoor Learning on School Children's Learning and Development. *Frontiers in Public Health*, *10*(May). https://doi.org/10.3389/fpubh.2022.877058

Mansoori, S. (2019). Classroom Conflicts and Effective Resolution Strategies. *International Journal of Peace, Education and Development*, *7*(2), 129–134. https://doi.org/10.30954/2454-9525.02.2019.7

Mardian, V., Suwarma, I. R., & Utama, J. A. (2023). The Study of Indonesian High School Students' Collaboration Skills: Student Self-Assessment. *International Journal of Science Education and Teaching*, *2*(3), 162–173. https://doi.org/10.14456/ijset.2023.14

Mariani, L., Trivellato, B., Martini, M., & Marafioti, E. (2022). Achieving Sustainable Development Goals through Collaborative Innovation: Evidence from Four European Initiatives. *Journal of Business Ethics*, *180*(4), 1075–1095. https://doi.org/10.1007/s10551-022-05193-z

Marklund, B. B., & Taylor, A.-S. lklind. (2016). Educational Games in Practice: The Challenges Involved in Conducting a Game-Based Curriculum. *Electronic Journal of E-Learning*, *14*(2), 121–135. https://eric.ed.gov/?id=EJ1101225

Martín-Gámez, C., Acebal, M. del C., & Prieto, T. (2018). Developing The Concept of 'Ecosystem' Through Inquiry-Based Learning: A Study of Pre-Service Primary Teachers. *Journal of Biological Education*, *54*(2), 147–161. https://doi.org/10.1080/00219266.2018.1554596

Martín, R. B., Palombo, N. E., Martinenco, R. M., & Manavella, A. M. (2023). Narratives of Learning in a Permacultural Cooperative: Some Inspiring Ideas for Science Education in the Light of Freire's Pedagogy. *Cultural Studies of Science Education*, *18*(1), 175–193. https://doi.org/10.1007/s11422-023-10164-5

Masihu, J. M., & Augustyn, S. (2021). Pengembangan Bahan Ajar Ekosistem

Berbasis Potensi Lokal di Maluku. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *07*(03), 133–143. https://doi.org/10.22437/bio.v7i3.13250

Massah, S. S. E. (2018). Addressing Free Riders in Collaborative Group Work in Higher Education. *International Journal of Educational Management*, *32*(7), 1223–1244. https://doi.org/10.1108/IJEM-01-2017-0012

Matovu, H., Won, M., Hernandez-Alvarado, R. B., Ungu, D. A. K., Treagust, D. F., Tsai, C. C., Mocerino, M., & Tasker, R. (2024). The Perceived Complexity of Learning Tasks Influences Students' Collaborative Interactions in Immersive Virtual Reality. *Journal of Science Education and Technology*, *33*(4), 542–555. https://doi.org/10.1007/s10956-024-10103-1

Maye, D. (2016). Examining Innovation for Sustainability from the Bottom Up: An Analysis of the Permaculture Community in England. *Sociologia Ruralis*, *58*(2), 331–350. https://doi.org/10.1111/soru.12141

Mazlan, M., Nuraida, N., Jelita, J., Paramitha Utari, A., & Ardiani, D. (2024). Outdoor Learning Based on The Local Environment to Improve Student Learning Activities and Outcomes on Single Substance Material at MIN 2 Aceh Tamiang. *At-Tarbawi: Jurnal Pendidikan, Sosial Dan Kebudayaan*, *11*(1), 196–203. https://doi.org/10.32505/tarbawi.v11i1.8913

McKay, J., & Sridharan, B. (2024). Student Perceptions of Collaborative Group Work (CGW) in Higher Education. *Studies in Higher Education*, *49*(2), 221–234. https://doi.org/10.1080/03075079.2023.2227677

Miller, A. N., Kordova, S., Grinshpoun, T., & Shoval, S. (2023). To be or Not to be a Systems Thinker: Do Professional Characteristics Influence How Students Acquire Systems-Thinking Skills? *Frontiers in Education*, *8*(2), 1–11. https://doi.org/10.3389/feduc.2023.1026488

Milliken, S., Ovca, A., Antenen, N., Villarroel, M., Bulc, T. G., Kotzen, B., & Junge, R. (2021). Aqu@Teach-The First Aquaponics Curriculum to be Developed Specifically for University Students. *Horticulturae*, *7*(2), 1–9. https://doi.org/10.3390/horticulturae7020018

Mircioiu, C., & Atkinson, J. (2017). A Comparison of Parametric and Non-Parametric Methods Applied to a Likert Scale. *Pharmacy*, *5*(2), 26–38. https://doi.org/10.3390/pharmacy5020026

Mobus, G. E. (2018). Teaching Systems Thinking to General Education Students. *Ecological Modelling*, *373*(9), 13–21. https://doi.org/10.1016/j.ecolmodel.2018.01.013

Mohan, M., Passi, V. R., Latika, M., Sandhya, P., Agam, A., Anirban, C., Naveen, K., & Rakesh, S. (2025). Empathy Development through Game-Based

Learning: An Investigative Study on Nursing Professionals. *Nurse Education Today*, *144*(1), 1–7. https://doi.org/10.1016/j.nedt.2024.106409

Mohr, K. A. J., & Mohr, E. S. (2017). Understanding Generation Z Students to Promote a Contemporary Learning Environment. *Journal on Empowering Teaching Excellence Volume*, *1*(1), 1–10. https://doi.org/10.15142/T3M05T

Mollison, B., & Holmgren, D. (1978). *Permaculture One: A Perennial Agriculture for Human Settlements*. Tagari.

Monat, J., Amissah, M., & Gannon, T. (2020). Practical Applications of Systems Thinking to Business. *Systems*, *8*(2), 1–19. https://doi.org/10.3390/systems8020014

Mullins, M. (2011). Designing a School Garden Space that Emphasizes Children's Wants and Uses Permaculture Design Methods Wants and Uses Permaculture Design Methods [University of Nebraska-Lincoln]. In *Educational Psychology Commons*. https://digitalcommons.unl.edu/envstudtheses

Mulyadiprana, A., Hamdu, G., & Ade, Y. (2024). STEL (System Thinking and ESD Learning) Model: Developing Elementary School Students' Systems Thinking Skills. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *10*(4), 1665–1674. https://doi.org/10.33394/jk.v10i4.12861

Muniz, M. C., da Silva, E. V., Barrile, J. P. R., Porto, R. M., & de Souza, J. A. (2025). Encouraging the teaching of science through composting. *Cornell University*, 1–22. http://arxiv.org/abs/2501.13313

Mustafa, M. N., Hermandra, ., Zulhafizh, ., & Hidayat, R. (2024). Classroom Management in Improving the Quality of Learning in the Education Units. *Journal of Higher Education Theory and Practice*, *24*(5), 56–69. https://doi.org/10.33423/jhetp.v24i5.7003

Mustamin, K., Wahdah, Dermawan, I., Abrina, M. J., & Petrus, J. (2014). The Impact of Project-Based Learning on Students' Collaboration Skills in Secondary Schools. *International Journal of Information, Business and Management*, *6*(2), 1–12. https://doi.org/10.55299/ijere.v3i2.740

Mustari, M., & Muhammad, I. (2023). Analysis of Classroom Management in Learning Quality, Affective Support and Cognitive Activation at Junior High School. *Jurnal Pendidikan*, *15*(3), 3776–3784. https://doi.org/10.35445/alishlah.v15i3.2928

Muti'ah, U. N., Makin, & Yuliatun. (2023). Have Teachers Conducted Collaborative Assessment in Elementary Schools? *The 2nd International Conference on Education Innovation and Social Science*, *July*, 712–719.

http://proceedings.ums.ac.id/iceiss/article/view/3393

Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of Digital Game-Based Learning on Student Engagement and Motivation. *Computers*, *12*(9), 1–23. https://doi.org/10.3390/computers12090177

Naim, R. M., Mutalib, M. A., & Shamsuddin, A. S. (2024). Navigating the Environmental, Economic and Social Impacts of Sustainable Agriculture and Food Systems: A Review. *Frontiers of Agricultural Science and Engineering*, *11*(4), 652–673. https://doi.org/10.15302/j-fase-2024550

Nakata, A., Vuopala, E., & Weinberger, A. (2025). Conflict experiences and management strategies in intercultural collaborative learning. *Research in Comparative and International Education*. https://doi.org/10.1177/17454999251329258

Nath, M. K. (2022). Potentialities of Permaculture to Emerge as an Alternative for Intensive Agriculture- A Review. *Indian Journal of Organic Farming*, *1*(1), 16–24. https://threesistersproject.language.iastate.edu/wp-content/uploads/sites/427/2023/08/Indian-Journal-of-Organic-Farming_-Potentialities-of-Permaculture-to-Emerge-as-an-Alternative-for-Intensive-Agriculture-A-Review.pdf

Nebel, S., Schneider, S., Schledjewski, J., & Rey, G. D. (2017). Goal-Setting in Educational Video Games: Comparing Goal-Setting Theory and the Goal-Free Effect. *Simulation and Gaming*, *48*(1), 98–130. https://doi.org/10.1177/1046878116680869

Nelvarina, N., Agustina, T. W., & Solikha, M. (2024). Can The Inquiry Learning Model Improve Students ' System Thinking Skills? *ASEAN Journal for Science Education*, *3*(1), 55–64. https://ejournal.bumipublikasinusantara.id/index.php/ajsed/article/view/364

Niang, M., Gagnon, M. P., & Dupéré, S. (2023). Using Systems Thinking to Understand the Scale-Up and Sustainability of Health Innovation: A Case Study of Seasonal Malaria Chemoprevention Processes in Burkina Faso. *BMC Public Health*, *23*(1), 1–14. https://doi.org/10.1186/s12889-023-16729-x

Niatun, M., & Purwati, N. (2023). Hubungan antara Pengetahuan tentang Ekosistem dengan Sikap Peduli Lingkungan pada Siswa SMA di Mataram. *EDUSTUDENT: Jurnal Ilmiah Pendidikan Dan Pengembangan Pembelajaran*, *2*(4), 233–238. https://doi.org/10.26858/edustudent.v2i4.47410

Ninaus, M., Cortez, R., Hazin, I., Kiili, K., Wortha, S. M., Klein, E., Weiss, E. M., & Moeller, K. (2023). The Added Value of Game Elements: Better Training Performance but Comparable Learning Gains. *Educational Technology*

Research and Development, *71*(5), 1917–1939. https://doi.org/10.1007/s11423-023-10263-8

Novo, C., Zanchetta, C., Goldmann, E., & Carvalho, C. V. De. (2024). The Use of Gamification and Web-Based Apps for Sustainability Education. *Sustainability*, *16*(3197), 1–30. https://doi.org/10.3390/su16083197

Nugroho, P. S., Nasir, M., Syafi'i, M., & Erviyenni, E. (2023). Profile Perception of Student's Collaboration and Creative Thinking Skills in Physics. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 775–779. https://doi.org/10.29303/jppipa.v9i2.3055

Nur Inayah, G., Rochintaniawati, D., & Sanjaya, Y. (2023). Analisis Penggunaan Media Pembelajaran dan Implementasi ESD yang Digunakan Guru Biologi SMA/MA. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *9*(2), 24–34. https://doi.org/10.22437/biodik.v9i2.18834

Nuraeni, R., Setiono, & Himatul, A. (2020). Profil Kemampuan Berpikir Sistem Siswa Kelas XI SMA pada Materi Sistem Pernapasan. *Pedagogi Hayati*, *4*(1), 1–9. https://doi.org/10.31629/ph.v4i1.2123

Nurfadilah, Z., & Rochintaniawati, D. (2021). Analisis Miskonsepsi Materi Ekosistem Pada Siswa Kelas X. *ISEJ: Indonesian Science Education Journal*, *2*(3), 151–157. https://doi.org/10.62159/isej.v2i3.326

Nurhayati, & Bahtiar. (2024). Student Learning Independence to Improve Communication and Collaboration Skills in View of Gender. *Journal of Education and E-Learning Research*, *11*(2), 239–252. https://doi.org/10.20448/jeelr.v11i2.5450

Nurhidayah, L., Riandi, & Solihat, R. (2020). Identifikasi Miskonsepsi Siswa SMA pada Topik Ekosistem (Identification of Senior High School Students' Misconception Regarding to the Ecosystem Topic). *Assimilation: Indonesian Journal of Biology Education*, *3*(1), 12–17. https://doi.org/10.17509/aijbe.v3i1.23303

Nurwahidah, Samsuri, T., Mirawati, B., & Indriati. (2021). Meningkatkan Keterampilan Kolaborasi Siswa Menggunakan Lembar Kerja Siswa Berbasis Saintifik. *REFLECTION JOURNAL*, *1*(2), 70–76. https://doi.org/10.36312/rj.v1i2.556

Odongo, E. E., Bbosa, W. K., & Kahunde, P. K. (2024). Black Soldier Fly (BSF): A Sustainable Solution for Protein, Waste Management, and a Circular Bio-Economy. *European Journal of Theoretical and Applied Sciences*, *2*(3), 822–834. https://doi.org/10.59324/ejtas.2024.2(3).64

OECD. (2018). *The Future of Education and Skills: Education 2030*. OECD

Education Working Papers. https://www.oecd.org/content/dam/oecd/en/publications/reports/2018/06/the-future-of-education-and-skills_5424dd26/54ac7020-en.pdf

Ofstedal, K., & Dahlberg, K. (2009). Collaboration in Student Teaching: Introducing the Collaboration Self-Assessment Tool the Emergence of Leadership in Students' Group Interaction in a School-Based Makerspace. *Journal of Early Childhood Teacher Education*, *30*(1), 37–48. https://doi.org/10.1080/10901020802668043

Olayvar, S. R. (2023). Integration of Game-Based Learning Approach as an Innovative Teaching Tool in Improving Students' Academic Performance in English. *International Journal of Instruction*, *16*(3), 677–690. https://doi.org/10.29333/iji.2023.16336a

Olsson, D., Gericke, N., & Pauw, J. B. (2022). The Effectiveness of Education for Sustainable Development Revisited – A Longitudinal Study on Secondary Students' Action Competence for Sustainability. *Environmental Education Research*, *28*(3), 405–429. https://doi.org/10.1080/13504622.2022.2033170

Oren, F. S. (2018). Self, Peer and Teacher Assessments: What is the Level of Relationship between Them? *European Journal of Education Studies*, *4*(7), 1–19. https://doi.org/10.5281/zenodo.1249959

Orgill, M., York, S., & Mackellar, J. (2019). Introduction to Systems Thinking for the Chemistry Education Community. *Journal of Chemical Education*, *96*, 2720–2729. https://doi.org/10.1021/acs.jchemed.9b00169

Ozturk, S., & Forsythe, M. E. (2024). Introducing Preservice Elementary Teachers to Permaculture Education. *Journal of Agricultural Education*, *65*(2), 361–382. https://doi.org/10.5032/jae.v65i2.2459

Padhi, D. R., Chavan, P., & Mitra, R. (2018). Understanding Systems Thinking from the Perspectives of Experience and Diversity. *Proceedings - IEEE 9th International Conference on Technology for Education, T4E 2018*, *12*, 122–125. https://doi.org/10.1109/T4E.2018.00033

Page, A. (2017). Implementing Cooperative Learning: A Consideration of Barriers and Enablers. *Journal of Initial Teacher Inquiry*, *3*, 49–52. http://hdl.handle.net/10092/14637

Pálsdóttir, A., & Jóhannsdóttir, L. (2021). Key Competencies for Sustainability in University of Iceland Curriculum. *Sustainability (Switzerland)*, *13*(16), 1–17. https://doi.org/10.3390/su13168945

Pang, C., Lau, J., Seah, C. P., Cheong, L., & Low, A. (2018). Socially Challenged Collaborative Learning of Secondary School Students in Singapore. *Education*

Sciences, *8*(1), 1–10. https://doi.org/10.3390/educsci8010024

Pardiansyah, S. A., Mihtarom, & Junaenik, L. G. (2024). Examining the Pros and Cons of Using Game-Based Learning For Vocabulary Instruction to Junior High School Students. *Indonesian Journal of English Teaching*, *12*(2), 1–9. https://doi.org/10.15642/ijet2.2024.13.2.117-126.

Parinduri, M. A., Fatimah, N., & Auliya, W. (2023). Implementasi Education Sustainable Development Pada Lembaga Pendidikan. *At-Tazakki: Jurnal Kajian Ilmu Pendidikan Islam Dan Humaniora*, *7*(2), 222–236. https://doi.org/10.29040/budimas.v4i1.3532

Parry, S., & Metzger, E. (2023). Barriers to Learning for Sustainability: A Teacher Perspective. *Sustainable Earth Reviews*, *6*(2), 1–11. https://doi.org/10.1186/s42055-022-00050-3

Patchen, A. K., Rakow, D. A., Wells, N. M., Hillson, S., & Meredith, G. R. (2024). Barriers to Children's Outdoor Time: Teachers' and Principals' Experiences in Elementary Schools. *Environmental Education Research*, *30*(1), 16–36. https://doi.org/10.1080/13504622.2022.2099530

Peabody, M. A., & Turesky, E. F. (2018). Adapting LEGO® SERIOUS PLAY® methodology in Higher Education. *International Journal of Management and Applied Research*, *5*(4), 1904–1912. https://doi.org/10.1109/EDUCON.2018.8363468

Portt, E., Person, S., Person, B., Rawana, E., & Brownlee, K. (2020). Empathy and Positive Aspects of Adolescent Peer Relationships: a Scoping Review. *Journal of Child and Family Studies*, *29*(9), 2416–2433. https://doi.org/10.1007/s10826-020-01753-x

Power, J. R., & Tanner, D. (2023). Peer Assessment, Self-Assessment, and Resultant Feedback: An Examination of Feasibility and Reliability. *European Journal of Engineering Education*, *48*(4), 615–628. https://doi.org/10.1080/03043797.2023.2185769

Praetorius, P. (2006). A Permaculture School Garden. *Green Teacher*, *6*(78), 6–10. http://search.proquest.com/docview/228629586?accountid=14719

Pratama, A., Afiah, N. N., Ismail, R. F., & Muhammad, K. (2024). Sustainability Practices Among Accounting Students: A Study of SDG Implementation at Universitas Padjadjaran. *Journal of Lifestyle and SDG'S Review*, *5*(1), 1–32. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n01.pe02976

Priyambodo, P., Pidi, Insih, W., & Djukri. (2023). Phenomenological Studies : Strategies for Improving Indonesian Pre-Service Teacher Collaboration Skills. *Pegem Journal of Education and Instruction*, *13*(3), 350–361.

https://doi.org/10.47750/pegegog.1

Puga, R. U. (2022). Game-Based Learning. A Tool That Enhances The Collaborative Work: A Case Study of Undergraduate Students. *Proceedings of the European Conference on Games-Based Learning*, *16*(1), 570–577. https://doi.org/10.34190/ecgbl.16.1.419

Pulgar, J., Ramírez, D., Umanzor, A., Candia, C., & Sánchez, I. (2022). Long-Term Collaboration with Strong Friendship Ties Improves Academic Performance in Remote and Hybrid Teaching Modalities in High School Physics. *Physical Review Physics Education Research*, *18*(1), 1–19. https://doi.org/10.1103/PhysRevPhysEducRes.18.010146

Purwoko, B. (2019). The Student's Conflict Resolution in Individual Psychological Dynamics. *3rd International Conference on Education Innovation (ICEI 2019)*, *Volume 387*, 366–370. https://doi.org/10.2991/icei-19.2019.87

Purwoko, B., Sartinah, E. P., Wulan, P. S., & Chinun, B. (2023). Enhanced Conflict Resolution Skills among Indonesian Students Based on Biblioeducational and Sociodrama Guidance. *The Journal of Behavioral Science (TJBS)*, *16*(1), 85–100. https://so06.tci-thaijo.org/index.php/IJBS/article/view/260457

Putri, M. A., Herprawati, & Rangga, F. (2025). The Influence of Game Based Learning on Student Motivation in the Digital Era: Literature Review. *Jurnal Teknologi Pendidikan: Jurnal Penelitian Dan Pengembangan Pembelajaran*, *10*(1), 122–131. https://doi.org/10.33394/jtp.v10i1.13814

Qian, M., & Clark, K. R. (2016). Game-Based Learning and 21st Century Skills: A Review of Recent Research. *Computers in Human Behavior*, *63*, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Raharjo, A. D., Putri, A. A., & Hafiz, R. B. (2024). The Use of Game-Based Learning to Increase Student Engagement. *Hipkin Journal of Educational Research*, *1*(1), 49–60. https://doi.org/10.64014/hipkin-jer.v1i3.30

Rahayuningsih, P., Hidayah, W., Cindy, N. P., & Nurmelia. (2022). Fungsi, dan Peran Media Pembelajaran sebagai Upaya Peningkatan Kemampuan Belajar Siswa. *Education Journal : Penelitian Ibnu Rusyd*, *1*(1), 1–11. https://doi.org/10.31800/jurnalkwangsan.v1i2.7

Rahmat, N. H. (2020). Conflict Resolution Strategies in Class Discussions. *International Journal of Education*, *12*(3), 49–66. https://doi.org/10.5296/ije.v12i3.16914

Rahmawati, S., Roshayanti, F., Nugroho, A. S., & Hayat, M. S. (2021). Potensi implementasi Education for Sustainable Development (ESD) dalam pembelajaran IPA di MTs Nahdlatul Ulama Mranggen Kabupaten Demak.

Jurnal Kualita Pendidikan, *2*(1), 15–27. https://doi.org/10.51651/jkp.v2i1.27

Rains, S., & Whitworth, B. A. (2018). Building an Aquaponics System in the Classroom. In *Better Way of Farming* (pp. 41–45). Tiger Prints. https://tigerprints.clemson.edu/teach_learn_pub

Ramadhan, F., Nadeak, T., & Aang, S. A. (2022). Sosialisasi Pembelajaran Ekosistem dan Proses Kehidupan IPA di SDN Dayeuhluhur 1. *Abdima Jurnal Pengabdian Masyarakat*, *2*(1), 1585–1591. https://journal.ubpkarawang.ac.id/index.php/AJPM/article/download/3796/2566/

Rapp, A. (2017). Drawing Inspiration from World of Warcraft: Gamification Design Elements for Behavior Change Technologies. *Interacting with Computers*, *29*(5), 648–678. https://doi.org/10.1093/iwc/iwx001

Ratinen, I., & Linnanen, L. (2022). Exploring Systems Thinking Competence of Finns in Fostering Sustainable Transformation. *World*, *3*(2), 287–298. https://doi.org/10.3390/world3020015

Raut, A. V, & Gupta, S. S. (2019). Reflection and Peer Feedback for Augmenting Emotional Intelligence among Undergraduate Students: A Quasi-experimental Study from a Rural Medical College in Central India. *Education for Health*, *32*(1), 1–10. https://doi.org/10.1108/eb055148

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad ke-21 dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1), 2239–2253. https://doi.org/10.15294/jipk.v13i1

Reiff, J., Rösch, V., Jungkunst, H. F., Mauser, K. M., Kampel, S., Regending, S., Zaller, J. G., & Entling, M. H. (2024). Permaculture Enhances Carbon Stocks, Soil Quality and Biodiversity in Central Europe. *Communications Earth & Environment*, *5*(305), 1–14. https://doi.org/10.1038/s43247-024-01405-8

Reimers, F. M. (2020). Transforming Education to Prepare Students to Invent the Future. *PSU Research Review*, *4*(2), 81–91. https://doi.org/10.1108/PRR-03-2020-0010

Reynders, M., Pilcher, L., & Potgieter, M. (2025). Development of Systems Thinking in a Large First-Year Chemistry Course Using a Group Activity on Detergents. *Journal of Chemical Education*, *102*(3), 1352–1366. https://doi.org/10.1021/acs.jchemed.4c01048

Reyssier, S., Hallifax, S., Serna, A., Marty, J. C., Simonian, S., & Lavoue, E. (2022). The Impact of Game Elements on Learner Motivation : Influence of Initial Motivation and Player Profile. *IEEE Transactions on Learning Technologies*, *15*(1), 1–15. https://doi.org/10.1109/TLT.2022.3153239

Riaz, M., & Din, M. (2023). Collaboration as 21st Century Learning Skill at Undergraduate Level. *SJESR: Sir Syed Journal of Education & Social Research*, *6*(1), 93–99. https://doi.org/10.36902/sjesr-vol6-iss1-2023(93-99)

Riess, H. (2017). The Science of Empathy. *Journal of Patient Experience*, *4*(2), 74–77. https://doi.org/10.1177/2374373517699267

Rocha, O., Kamphambale, D., MacMahon, C., Coetzer, J. H., & Morales, L. (2023). The Power of Education in a Globalised World: Challenging Geoeconomic Inequalities. *Peace Review*, *35*(4), 708–723. https://doi.org/10.1080/10402659.2023.2270501

Rodríguez, A. C. A., & Silva, C. B. (2025). Common Humanity and Valuing Others' Well-Being as Ways to Expand Compassion and Prosocial Behavior Beyond Friends for Achieving Sustainable Development Goals (SDGs). *Journal of Lifestyle and SDGs Review*, *5*(5), e03463. https://doi.org/10.47172/2965-730x.sdgsreview.v5.n05.pe03463

Ross, N. (2023). *Permaculture Curriculum for Public School Children in the United States* [Hamline University]. https://digitalcommons.hamline.edu/hse_cp/931

Roux-Rosier, A., Azambuja, R., & Gazi, I. (2018). Alternative Visions : Permaculture as Imaginaries of the Anthropocene. *Organization*, *25*(4), 550–572. https://doi.org/10.1177/1350508418778647

Rusady, M. V., Fauzi, A., Triyan, A., Bachri, S., Meyrlon Ballo, M. A., & Nuru, E. (2024). Conflict Management Strategies : Improving Team Performance Through Collaboration and Communication (Human Resource Management Literature Study). *Dinasti International Journal of Education Management and Social Science (DIJEMSS)*, *5*(5), 1005–1017. https://doi.org/10.31933/dijemss.v5i5

Rusoja, E., Haynie, D., Sievers, J., Mustafee, N., Nelson, F., Reynolds, M., Sarriot, E., Swanson, R. C., & Williams, B. (2018). Thinking about Complexity in Health: A Systematic Review of the Key Systems Thinking and Complexity Ideas in Health. *Journal of Evaluation in Clinical Practice*, *24*(3), 600–606. https://doi.org/10.1111/jep.12856

Rustamova, B. (2025). The Role of Empathy in Group Learning and Collaboration. *Science and Innovation: International Scientific Journal*, *4*(3), 8–11. https://doi.org/10.5281/zenodo.15034543

Rusticus, S. A., & Justus, B. J. (2019). Comparing Student- and Teacher-Formed Teams on Group Dynamics, Satisfaction, and Performance. *Small Group Research*, *50*(4), 443–457. https://doi.org/10.1177/1046496419854520

Ryzin, V. M. J., & Roseth, C. J. (2019). Effects of Cooperative Learning on Peer Relations, Empathy, and Bullying in Middle School. *Aggressive Behavior*, *45*(6), 643–651. https://doi.org/10.1002/ab.21858

Saefudin, Kusnadi, Suwandi, T., Najira, Baharuddin, R., & Rachman, H. T. (2025). Integration of Permaculture to Reinvent Students' Interest in Nature and Environmental Awareness for Quality Education Under SDG-4. *Jurnal Pendidikan IPA Indonesia*, *14*(1), 192–201. https://doi.org/10.15294/jpii.v14i1.22122

Sailer, M., & Homner, L. (2020). The Gamification of Learning: A Meta-analysis. *Educational Psychology Review*, *32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sakinah, S. B., Idrus, A. Al, & Syukur, A. (2023). Pengembangan LKPD Berbasis Ekosistem Mangrove Melalui Model Project Based Learning Untuk Meningkatkan Pemahaman Konsep Tentang Ekosistem di SMAN 1 Lembar. *Jurnal Ilmiah Profesi Guru*, *8*(3), 1245–1251. https://doi.org/10.29303/jipp.v8i3.1258

Salsabila, M. S., Sanjaya, Y., Eliyawati, E., & Suttiwan, W. (2024). Enhancing Junior High School Students ' System Thinking Competency through Water Treatment with Plant Modification : A Focus on Environmental Pollution. *Journal of Science Learning*, *7*(1), 17–24. https://doi.org/10.17509/jsl.v7i1.61674

Samanta, Jabu, B., & Gemintastiti, S. (2024). Students' Perceptions Toward Gamification Applied. *Journal of Technology in Language Pedagogy (JTechLP)*, *3*(3), 565–585. https://doi.org/10.26858/jtechlp.v3i3,%20Sept.66660

Sanjaya, W. (2014). *Penelitian Pendidikan: Jenis, Metode, dan Prosedur* (1st ed.). Kencana.

Santos, S. M. G., Gaspar, A. T. F. S., & Schiozer, D. J. (2021). Information, Robustness, and Flexibility to Manage Uncertainties in Petroleum Field Development. *Journal of Petroleum Science and Engineering*, *196*(2021), 1–18. https://doi.org/10.1016/j.petrol.2020.107562

Sarjani, L. P. W., Suastra, I. W., & Subagia, I. W. (2023). The Influence of Project-Based Learning Models on Collaboration Skills and Science Learning Outcome for Junior High School. *Jurnal Penelitian Pendidikan IPA*, *9*(Special Issue), 1284–1292. https://doi.org/10.29303/jppipa.v9ispecialissue.7243

Saxena, M., & Mishra, D. K. (2021). Gamification and Gen Z in Higher Education: A Systematic Review of Literature. *International Journal of Information and Communication Technology Education*, *17*(4), 1–22.

https://doi.org/10.4018/IJICTE.20211001.oa10

Scager, K., Boonstra, J., Peeters, T., Vulperhorst, J., & Wiegant, F. (2016). Collaborative Learning in Higher Education: Evoking Positive Interdependence. *CBE Life Sciences Education*, *15*(4), 1–9. https://doi.org/10.1187/cbe.16-07-0219

Schaik, F. (2023). What Happens if …? Uncertainty in Games and Climate Change Education. *Environmental Education Research*, *29*(12), 1891–1910. https://doi.org/10.1080/13504622.2023.2225811

Scherer, L., & Verburg, P. H. (2017). Mapping and Linking Supply and Demand-Side Measures In Climate-Smart Agriculture. A Review. *Agronomy for Sustainable Development*, *37*(66), 1–17. https://doi.org/10.1007/s13593-017-0475-1

Schuler, S., Fanta, D., Rosenkraenzer, F., & Riess, W. (2017). Systems Thinking within the Scope of Education for Sustainable Development (ESD) – A Heuristic Competence Model as a Basis for (Science) Teacher Education. *Journal of Geography in Higher Education*, *4*(3), 192–204. https://doi.org/10.1080/03098265.2017.1339264

Schulz, S., Berndt, S., & Hawlitschek, A. (2023). Exploring Students' and Lecturers' Views on Collaboration and Cooperation in Computer Science Courses - A Qualitative Analysis. *Computer Science Education*, *33*(3), 318–341. https://doi.org/10.1080/08993408.2021.2022361

Scoular, C., Duckworth, D., Heard, J., & Ramalingam, D. (2020). *Collaboration: Skill Development Framework* (2nd ed.). Australian Council for Educational Research. https://doi.org/10.37517/978-1-74286-751-9

Scoular, C., Duckworth, D., Heard, J., & Ramalingam, D. (2025). *Collaboration: Skill Development Framework* (2nd Ed). Australian Council for Educational Research. https://doi.org/10.37517/978-1-74286-751-9

Selman, Y. F., & Jaedun, A. (2020). Evaluation of The Implementation of 4C Skills in Indonesian Subject at Senior High Schools. *Jurnal Pendidikan Indonesia*, *9*(2), 244–257. https://doi.org/10.23887/jpi-undiksha.v9i2.23459

Semiz, G. K. (2021). Systems Thinking Research in Science and Sustainability Education: A Theoretical Note. In *Transitioning to Quality Education*. Basel: MDPI. https://doi.org/10.3390/books978-3-03897-893-0-3

Semiz, G. K., & Teksöz, G. (2019). Developing the Systems Thinking Skills of Pre-Service Science Teachers through an Outdoor ESD Course. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 337–356. https://doi.org/10.1080/14729679.2019.1686038

Shimizu, I., Kikukawa, M., Tada, T., Kimura, T., Duvivier, R., & Van Der Vleuten, C. (2020). Measuring Social Interdependence in Collaborative Learning: Instrument Development and Validation. *BMC Medical Education*, *20*(1), 1–9. https://doi.org/10.1186/s12909-020-02088-3

Shishavan, H. B., & Jalili, M. (2020). Responding to Student Feedback: Individualising Teamwork Scores Based on Peer Assessment. *International Journal of Educational Research Open*, *1*(1), 1–13. https://doi.org/10.1016/j.ijedro.2020.100019

Sinakou, E., Boeve-de Pauw, J., & Van Petegem, P. (2017). Exploring the Concept of Sustainable Development within Education for Sustainable Development: Implications for ESD Research and Practice. *Environment, Development and Sustainability*, *21*(1), 1–10. https://doi.org/10.1007/s10668-017-0032-8

Situmorang, R. P., Suwono, H., Munzil, Susanto, H., Chang, C. Y., & Liu, S. Y. (2024). Learn Biology Using Digital Game-Based Learning: A Systematic Literature Review. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(6), 1–25. https://doi.org/10.29333/EJMSTE/14658

Skinner, H., Sarpong, D., & White, G. R. T. (2018). Meeting The Needs of the Millennials and Generation Z: Gamification in Tourism through Geocaching. *Journal of Tourism Futures*, *4*(1), 1–14. https://doi.org/10.1108/JTF-12-2017-0060

Smiderle, R., Rigo, S. J., Marques, L. B., Peçanha de Miranda Coelho, J. A., & Jaques, P. A. (2020). The Impact of Gamification on Students' Learning, Engagement and Behavior Based on Their Personality Traits. *Smart Learning Environments*, *7*(3), 1–11. https://doi.org/10.1186/s40561-019-0098-x

Snapir, Z., Eberbach, C., Ben-Zvi-Assaraf, O., Hmelo-Silver, C., & Tripto, J. (2017). Characterising the Development of the Understanding of Human Body Systems in High-School Biology Students – A Longitudinal Study. *International Journal of Science Education*, *39*(15), 2092–2127. https://doi.org/10.1080/09500693.2017.1364445

Sousa, M. J., & Rocha, Á. (2018). Leadership Styles and Skills Developed through Game-Based Learning. *Journal of Business Research*, *94*(9), 360–366. https://doi.org/10.1016/j.jbusres.2018.01.057

Souza, V. S., Marques, S. R. B. V, & Veríssimo, M. (2019). How Can Gamification Contribute to Achieve SDGs?: Exploring The Opportunities and Challenges of Ecogamification for Tourism. *Journal of Hospitality and Tourism Technology*, *11*(2), 255–276. https://doi.org/10.1108/JHTT-05-2019-0081

Sridharan, B., & Boud, D. (2019). The Effects of Peer Judgements on Teamwork and Self-Assessment Ability in Collaborative Group Work. *Assessment and*

Evaluation in Higher Education, *44*(6), 894–909. https://doi.org/10.1080/02602938.2018.1545898

Stanfield, E., Slown, C. D., Sedlacek, Q., & Worcester, S. E. (2022). A Course-Based Undergraduate Research Experience (CURE) in Biology: Developing Systems Thinking through Field Experiences in Restoration Ecology. *CBE Life Sciences Education*, *21*(2), 1–16. https://doi.org/10.1187/cbe.20-12-0300

Stehle, S. M., & Peters-Burton, E. E. (2019). Developing Student 21st Century Skills in Selected Exemplary Inclusive STEM High Schools. *International Journal of STEM Education*, *1*, 1–15. https://doi.org/10.1186/s40594-019-0192-1

Stodulka, T. (2024). Tasting the Soil and Mobilizing the Future: Pedagogies of Hope in Timor-Leste's Permaculture Youth Camps. *American Behavioral Scientist*, 1–23. https://doi.org/10.1177/00027642241246691

Strauß, S., & Rummel, N. (2021). Promoting Regulation of Equal Participation in Online Collaboration by Combining a Group Awareness Tool and Adaptive Prompts. But Does It Even Matter? *International Journal of Computer-Supported Collaborative Learning*, *16*(1), 67–104. https://doi.org/10.1007/s11412-021-09340-y

Su, F., & Zou, D. (2024). A Systematic Review of Game-Based Assessment in Education in the Past Decade. *Knowledge Management and E-Learning*, *16*(3), 451–476. https://doi.org/10.34105/j.kmel.2024.16.021

Sugiyono. (2019). *Metode Penelitian: Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Sullivan, G. M., & Artino, A. R. (2013). Analyzing and Interpreting Data From Likert-Type Scales. *Journal of Graduate Medical Education*, *5*(4), 541–542. https://doi.org/10.4300/jgme-5-4-18

Sun, L., Kangas, M., & Ruokamo, H. (2024). Game-Based Features in Intelligent Game-Based Learning Environments: A Systematic Literature Review. *Interactive Learning Environments*, *32*(7), 3431–3447. https://doi.org/10.1080/10494820.2023.2179638

Susaniari, N. K. A. C., & Santosa, M. H. (2024). A Systematic Review on the Implementation of Game-Based Learning to Increase EFL Students' Motivation. *Journal of English Language and Education*, *9*(6), 77–87. https://doi.org/10.31004/jele.v9i6.520

Syafitri, E., Afriani, D. T., & Sri, M. (2024). Community Empowerment through Black Soldier Fly Maggot Farming Using Household Waste. *Transformasi: Jurnal Pengabdian Masyarakat*, *20*(1), 51–63. https://doi.org/10.20414/transformasi.v20i1.9266

Syaifullah, Rachmadiarti, F., Setiawan, B., & Suwandi, E. (2025). Integrated Science Learning Webbed Type in Permaculture Theme and BRADeR Model to Enhance Science Literacy Competence of Junior High School Students. *IJORER: International Journal of Recent Educational Research*, *6*(2), 379–397. https://doi.org/10.46245/ijorer.v6i2.786 ABSTRACT

Syarifudin, Haris, A., & Nurrahman. (2025). Patterns of Student Thinking Interaction in Group Discussion: The Effect of Explorative Interaction on Understanding Statistical Concepts. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *9*(2), 523–537. https://doi.org/10.31764/jtam.v9i2.30091

Tan, S. E., & Jung, I. (2024). Unveiling The Dynamics and Impact of Emotional Presence in Collaborative Learning. *International Journal of Educational Technology in Higher Education*, *21*(44), 1–18. https://doi.org/10.1186/s41239-024-00477-y

Tariq, R. (2024). A Framework for Corporate Sustainability: The Role of Systems Thinking. *Premier Journal of Business and Management Review*, *1*(100007), 1–7. https://doi.org/10.70389/PJBM.100007

Thelen, J., Fruchtman, C. S., Bilal, M., Gabaake, K., Iqbal, S., Keakabetse, T., Kwamie, A., Mokalake, E., Mupara, L. M., & Seitio-, O. (2023). Development of the Systems Thinking for Health Actions framework: A Literature Review and a Case Study. *BMJ Global Health*, *8*, 1–10. https://doi.org/10.1136/bmjgh-2022-010191

Thornhill-miller, B., Camarda, A., Mercier, M., Burkhardt, J., Morisseau, T., Bourgeois-bougrine, S., Vinchon, F., Hayek, S. El, Augereau-landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(54), 1–32. https://doi.org/10.3390/jintelligence11030054

Topping, K. (2017). Peer Assessment : Learning by Judging and Discussing the Work of Other Learners. *Interdisciplinary Education and Psychology*, *1*(1), 1–17. https://doi.org/10.31532/interdiscipeducpsychol.1.1.007

Torres-Toukoumidis, A., Vintimilla, D., De-santis, A., & Carlos, P. (2022). Gamification in Ecology-Oriented Mobile Applications—Typologies and Purposes. *Societies*, *12*(42), 1–12. https://doi.org/10.3390/soc12020042

Torsvik, M., Johnsen, H. C., Lillebo, B., Reinaas, L. O., & Vaag, J. R. (2021). Has "The Ceiling" Rendered the Readiness for Interprofessional Learning Scale (RIPLS) Outdated? *Journal of Multidisciplinary Healthcare*, *14*, 523–531. https://doi.org/10.2147/JMDH.S296418

Triana, B. M. (2023). Potret Miskonsepsi Siswa SMA pada Materi Komponen Penyusun dan Interaksi dalam Ekosistem. *Jurnal BIOEDUIN*, *13*(2), 49–57. https://doi.org/10.15575/bioeduin.v13i2.18766

Turner, J. R., & Baker, R. M. (2019). Complexity Theory: An Overview with Potential Applications for the Social Sciences. *Systems*, *7*(4), 1–22. https://doi.org/10.3390/systems7010004

Ulfa, S. W., Saragih, F. E., Sinurat, Y., Achyari, P. R., Pulungan, R. D., & Lubis, M. F. M. (2024). Analisis Miskonsepsi Buku Biologi Kurikulum 2013 Kelas X pada Materi Ekosistem. *Journal Innovation in Education (INOVED)*, *2*(3), 174–179. https://doi.org/10.59841/inoved.v2i3.1406

UNESCO. (2017). *Education for Sustainable Development Goals*. United Nations Educational, Scientific and Cultural Organization.

United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. United Nation. https://doi.org/10.1007/978-3-031-07461-5_1

Urry, L. A., Cain, M. L., Peter, V. M., Steven, A. W., & Rebecca, B. O. (2011). Campbell Biology. In *The Karoo* (Twelfth Ed). Pearson Education Inc. https://doi.org/10.1017/cbo9780511541988.013

Vachliotis, T., Salta, K., & Tzougraki, C. (2021). Developing Basic Systems Thinking Skills for Deeper Understanding of Chemistry Concepts in High School Students. *Thinking Skills and Creativity*, *41*(May), 100881. https://doi.org/10.1016/j.tsc.2021.100881

Vazquez-Brust, D., Piao, R. S., de Melo, M. F. de S., Yaryd, R. T., & M. Carvalho, M. (2020). The Governance of Collaboration for Sustainable Development: Exploring the "Black Box." *Journal of Cleaner Production*, *256*, 1–12. https://doi.org/10.1016/j.jclepro.2020.120260

Vitari, C., & David, C. (2017). Sustainable Management Models: Innovating through Permaculture. *Journal of Management Development*, *36*(1), 14–36. https://doi.org/10.1108/JMD-10-2014-0121

Vogel, N., & Wood, E. (2023). Collaborative Group Work: University Students' Perceptions and Experiences Before and during COVID-19. *SN Social Sciences*, *3*(6), 1–18. https://doi.org/10.1007/s43545-023-00670-2

Vuorio, E., Pernaa, J., & Aksela, M. (2024). Lessons for Sustainable Science Education: A Study on Chemists' Use of Systems Thinking across Ecological, Economic, and Social Domains. *Education Sciences*, *14*(7), 1–26. https://doi.org/10.3390/educsci14070741

Wagino, W., Maksum, H., Purwanto, W., Krismadinata, K., Suhendar, S., & Koto, R. D. (2023). Exploring the Full Potential of Collaborative Learning and E-Learning Environments in Universities: A Systematic Review. *TEM Journal*, *12*(3), 1772–1785. https://doi.org/10.18421/TEM123-60

Walker, E., Bormpoudakis, D., & Tzanopoulos, J. (2021). Assessing Challenges and Opportunities for Schools' Access to Nature in England. *Urban Forestry and Urban Greening*, *61*, 1–11. https://doi.org/10.1016/j.ufug.2021.127097

Walter, A., Klammsteiner, T., Gassner, M., Heussler, C. D., Kapelari, S., Schermer, M., & Insam, H. (2020). Black Soldier Fly School Workshops as Means to Promote Circular Economy and Environmental Awareness. *Sustainability (Switzerland)*, *12*(22), 1–13. https://doi.org/10.3390/su12229574

Wambsganss, T., Soellner, M., Koedinger, K. R., & Leimeister, J. M. (2022). Adaptive Empathy Learning Support in Peer Review Scenarios. *Conference on Human Factors in Computing Systems - Proceedings*, *March*, 1–17. https://doi.org/10.1145/3491102.3517740

Wang, & Fränti, P. (2022). Power Distance in Cross-Cultural Environment: Observations from Two Chinese Companies in Europe. *STEM Education*, *2*(3), 173–196. https://doi.org/10.3934/steme.2022012

Wang, X., Song, G., & Ghannam, R. (2024). Enhancing Teamwork and Collaboration: A Systematic Review of Algorithm-Supported Pedagogical Methods. *Education Sciences*, *14*(6), 1–24. https://doi.org/10.3390/educsci14060675

Wang, Yang, Y., & Lu, J. (2024). A Review of Aquaponics: Concept, Current Situation and Development. *International Journal of Agriculture and Natural Resources*, *51*(3), 140–156. https://doi.org/10.7764/ijanr.v51i3.2554

Widodo, A. (2021). *Pembelajaran Ilmu Pengetahuan Alam: Dasar-Dasar untuk Praktik*. UPI Press.

Widodo, A., Sriyati, S., Purwianingsih, W., Rochintaniawati, D., Solihat, R., & Siswandari, P. (2023). *Pengembangan Nilai-Nilai Keberlanjutan melalui Pelajaran Sains*. UPI Press. https://upipress.upi.edu

Williams, A., Kennedy, S., Philipp, F., & Whiteman, G. (2017). Systems Thinking: A Review of Sustainability Management Research. *Journal of Cleaner Production*, *148*, 866–881. https://doi.org/10.1016/j.jclepro.2017.02.002

Wong, F. M. F., Kan, C. W. Y., & Susan, K. Y. C. (2022). From Resistance to Acceptance in Small Group Work: Students' Narratives. *Nurse Education Today*, *111*, 1–17. https://doi.org/10.1016/j.nedt.2022.105317

Wood, S. L. R., Jones, S. K., Johnson, J. A., Brauman, K. A., Chaplin-Kramer, R., Fremier, A., Girvetz, E., Gordon, L. J., Kappel, C. V., Mandle, L., Mulligan, M., O'Farrell, P., Smith, W. K., Willemen, L., Zhang, W., & DeClerck, F. A. (2018). Distilling the Role of Ecosystem Services in the Sustainable Development Goals. *Ecosystem Services*, *29*, 70–82. https://doi.org/10.1016/j.ecoser.2017.10.010

Worsley, M., Anderson, K., Melo, N., & Jang, J. (2021). Designing Analytics for Collaboration Literacy and Student Empowerment. *Journal of Learning Analytics*, *8*(1), 30–48. https://doi.org/10.18608/JLA.2021.7242

Wu, & Leung, S. O. (2017). Can Likert Scales be Treated as Interval Scales?—A Simulation Study. *Journal of Social Service Research*, *43*(4), 527–532. https://doi.org/10.1080/01488376.2017.1329775

Wu, M. L. (2018). Making Sense of Digital Game-Based Learning: A Learning Theory-Based Typology Useful for Teachers. *Journal of Studies in Education*, *8*(4), 1–14. https://doi.org/10.5296/jse.v8i4.13022

Xiao, J. (2022). Potential Negative Impact of Gamification Education: A Review of Gamification Research. *Proceedings of the 2022 8th International Conference on Humanities and Social Science Research (ICHSSR 2022)*, *664*, 2179–2182. https://doi.org/10.2991/assehr.k.220504.395

Xu, Z., & Peng, J. (2024). Recognizing Ecosystem Service's Contribution to SDGs: Ecological Foundation of Sustainable Development. *Geography and Sustainability*, *5*(4), 511–525. https://doi.org/10.1016/j.geosus.2024.05.001

Yadav, S. P. S., Lahutiya, V., Ghimire, N. P., Yadav, B., & Paudel, P. (2023). Heliyon Exploring Innovation for Sustainable Agriculture: A Systematic Case Study of Permaculture in Nepal. *Heliyon*, *9*, 1–17. https://doi.org/10.1016/j.heliyon.2023.e15899

Yaman, H., Sousa, C., Neves, P. P., & Luz, F. (2024). Implementation of Game-Based Learning in Educational Contexts: Challenges and Intervention Strategies. *Electronic Journal of E-Learning*, *22*(10), 19–36. https://doi.org/10.34190/ejel.22.10.3480

Yean, C. P., Sarif, S., Ahmad, N., & Er, C. T. (2024). Exploring The Influence of Conflict in Group Work. *International Journal of Academic Research in Business and Social Sciences*, *14*(2), 1184–1199. https://doi.org/10.6007/ijarbss/v14-i2/20762

Yildiz, K. (2022). Experiential Learning from the Perspective of Outdoor Education Leaders. *Journal of Hospitality, Leisure, Sport and Tourism Education*, *30*, 1–13. https://doi.org/10.1016/j.jhlste.2021.100343

Yli-Panula, E., Jeronen, E., Vesterkvist, S., & Tolonen, P. (2022). Finnish Subject Student Teachers’ Views on Their Social Competencies at the End of Their Educational Studies. *Transitioning to Quality Education*, 63–87. https://doi.org/10.3390/books978-3-03897-893-0-4

York, S., Lavi, R., Dori, Y. J., & Orgill, M. K. (2019). Applications of Systems Thinking in STEM Education. *Journal of Chemical Education*, *96*(12), 2742–2751. https://doi.org/10.1021/acs.jchemed.9b00261

Yudha, P. A., Amuiza, C. B., & Abraham, M. R. (2017). *Sekolah Alam di Dusun Magersari Tulungagung dengan Konsep Permakultur* [Universitas Brawijaya]. http://repository.ub.ac.id/id/eprint/145555

Yushaa, S. M., Mazlina, S., Khuzzan, S., & Hanid, M. (2021). Gamification Elements and Its Impact on Students. *Journal of Technology and Operations Management*, *16*(2), 62–75. https://doi.org/10.32890/jtom2021.16.2.6

Zainul, A., & Nasution, N. (2001). *Penilaian Hasil Belajar*. Departemen Pendidikan Nasional.

Zeng, B., Jeon, M., & Wen, H. (2024). How Does Item Wording Affect Participants' Responses in Likert Scale? Evidence from IRT Analysis. *Frontiers in Psychology*, *15*(1304870), 1–10. https://doi.org/10.3389/fpsyg.2024.1304870

Zhang, Bekker, T., Markopoulos, P., & Skovbjerg, H. M. (2024). Supporting and Understanding Students' Collaborative Reflection-in-Action during Design-Based Learning. In *International Journal of Technology and Design Education* (Vol. 34, Issue 1). Springer Netherlands. https://doi.org/10.1007/s10798-023-09814-0

Zhang, M., & Chen, W. (2022). Assessing Collaborative Writing in The Digital Age: An Exploratory Study. *Journal of Second Language Writing*, *57*(9), 1–7. https://doi.org/10.1016/j.jslw.2022.100868

Zheng, E., & Wang, Q. (2023). Emerging Technologies in Learning. *International Journal of Emerging Technologies in Learning*, *18*(17), 33–44. https://doi.org/10.3991/ijet.v18i17.42851

Zhou, Hmelo-Silver, C. E., Ryan, Z., Stiso, C., Murphy, D., Danish, J., Chinn, C. A., & Duncan, R. G. (2024). Disagreeing Softly: Supporting Students in Managing Disagreement in Peer Critique. *International Journal of Computer-Supported Collaborative Learning*, *2*(1), 1–24. https://doi.org/10.1007/s11412-024-09438-z

Zhou, T., & Colomer, J. (2024). Education Sciences and Individual Accountability: A Systematic Review. *Education Sciences*, *14*(6), 1–15.

https://doi.org/10.3390/educsci14060567

Zidan, Z., Maftuhah, M., Yusti, D., Rahmat, A. A. R., Riandi, R., & Kusnadi, K. (2023). Learning Strategies on Ecosystem Concepts and Environmental Change: A Pedagogical Study Analysis. *Assimilation: Indonesian Journal of Biology Education*, *6*(2), 141–152. https://doi.org/10.17509/aijbe.v6i2.59777

Zidan, Z., Saefudin, Kusnadi, & Hastika, A. D. (2024). Using Gamification-based Program to Increase Student Creativity Skills in Sustainable Development Topics. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2603–2611. https://doi.org/10.29303/jppipa.v10i5.6737

Zimmer, K. (2016). *Permaculture in Higher Education: Opportunities and Challenges* [University of Victoria]. http://hdl.handle.net/1828/7200

Zong, B., Sun, Y., & Li, L. (2024). Advances, Hotspots, and Trends in Outdoor Education Research: A Bibliometric Analysis. *Sustainability (Switzerland)*, *16*(22), 1–21. https://doi.org/10.3390/su162210034